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HYDRAULICKING THE TRENCH FOR THE OAKLAND HARBOR QUAY WALL. (See page 635.)

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# EDITORIAL

APPROACH of the Thanksgiving season is heralded by a scramble on the part of several European nations to participate in the dismemberment of Turkey.

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CONTROVERSY between the leading candidates for the highest office in the land concerning the ethics of politics reminds us of the story of the man who, upon seeing a giraffe for the first time, looked the animal over from head to foot, and then turned away with the remark, "There ain't no such animal."

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IN response to a request from one of our readers, we publish in this issue, through the courtesy of Mr. A. H. Babcock, directions and formula for ascertaining, by means of a yardstick, the amount of liquid contained in a horizontal cylindrical tank. The mathematical discussion of the problem is an interesting application of calculus, and its solution will be of interest to every motor-car owner.

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AN interesting report of the results of the application of electricity to pumping in the oilfields has come from Taft, California. The Chanslor Canfield Midway Oil Company states that the average production of 62 wells by pumping was 103.8 barrels. The depth ranged from 1000 to 3000 feet, the average being 1528 feet. The power consumption of each well averaged 68½ kilowatts per day at a cost of $1.02. The average cost of pumping a well 1500 feet deep by steam is $270 per month, or $9 per day. Pumping by electricity therefore costs only one-ninth as much as steam.

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"ENGLISH as she is wrote" occasioned much merriment at the time of its publication, and the following gem, culled from questions asked during a Civil Service examination, would suggest an opportunity for the compilation of a book dealing with "Questions as she is asked." "Supposing," said the examiner, "you had removed the manhole gaskets, had tightened up the nuts on the manhole dogs, and had got 125 pounds of steam, what would you do if a dog came off and the manhole plate fell in?" "I'd go in after it," answered the candidate. "Any plate that could fall in against a pressure of 125 pounds would be worth going after."

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RUMORS have been rife for some time past concerning the condition of the Big Meadows dam that has been under construction for some time past for the Great Western Power Company. The story that seems to have gained credence in some quarters is, in effect, that the foundations were insecure, that the dam as designed could not withstand the pressure of the water it was intended to hold, that the Federal and State authorities had ordered all work stopped and had condemned the entire structure as a menace to the lives and property of the people residing below the damsite. As is often the case, the story is entirely without foundation in fact, and has all the indications of an attempt to influence the stock market for speculative purposes.



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Eminent engineers have passed upon and approved of the project at every stage since its inception, and their personal reputations are the best guarantee that could be given that the design and construction are as sound as human skill can make them. Such rumors, like the story of the three black crows, lose nothing in the telling, and the straightforward statement by Mr. Fleishhacker published in the daily press should quiet any apprehension that may have been felt on this score.

## The New West

"Go West, young man," is a saying that was never more significant than it is today. Sixty years ago emigrants braved the perils of the long journey westward in prairie schooners, spurred on by the tales of gold that could be picked up in the streets. In 1915 their prototypes will be found in the vast throng who will journey from Europe in ocean liners, attracted by the prospect of golden crops garnered from the vast cultivable area of the Pacific Coast states. The opening of the Panama-Pacific Exposition has a far greater significance than the mere grouping of exhibits showing international progress and development. It will mark the passing of the West of old, the birth of the new or greater West, and the beginning of an epoch of development that will move the centre of population toward the Rockies at a speed that will astonish the world. While the great cities of the Pacific Coast will become greater, the bulk of the new population will invade the interior, taking advantage of the opportunities afforded in the development of the vast natural resources of this almost virgin territory. It is not possible to do more than touch briefly on the extensive program of betterment now under way to prepare for the influx of new population. San Francisco will probably expend on the Spring Valley and Hetch-Hetchy water projects an amount exceeding $75,000,000. New wharves and docks are under way and will cost $5,000,000. An auxiliary salt-water fire-protection system is now practically completed that gives assurance that the city will never again be destroyed by fire. A municipal street railway is under construction and will cost when completed over $2,000,000. There are many other municipal betterment projects under way, aggregating over $25,000,000. The Panama-Pacific Exposition, when completed and thrown open to visitors, will represent an expenditure of more than $50,000,000. Los Angeles in the south is bending every energy to be ready to compete for a share of the new trade. The Los Angeles aqueduct, providing a water-supply for 1,000,000 people, will be completed in the spring of 1913, at a cost of $24,500,000. With characteristic energy, the problem of providing a deep-water harbor has been solved in the great works now under construction at San Pedro. Many millions will be spent, the plans embracing the construction of a comprehensive system of wharves, channel dredging, jetty and breakwater construction, and a municipal railway between the city proper and the harbor. San Diego is in no way behind in the march of progress. The people have voted to purchase the Southern California Mountain Water Company for $2,500,000, thereby obtaining a bountiful water-supply of exceptional purity. The Panama-California Exposition, to be held in 1913, will draw increased attention to the attractions of that portion of southern California tributary to San Diego. The

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California State Highway Commission, with $18,000,000 to spend on a great trunk highway to extend from the Mexican to the Oregon line, is making excellent progress. Several sections have already been completed and work is in progress at a score of points. Abundant and cheap power is the key to the industrial development of any community. That Nature has been lavish in her bestowal of favors is shown by the fact that California has a greater developed water-power than any state in the Union, while the production of fuel oil, reaching a total of nearly 80,000,000 barrels annually, not only exceeds that of any other state, but represents one-third of the total production of the United States. The advent of the Diesel and crude-oil gas-producer engines opens new fields for the installation of isolated power-plants and assures not only a great increase in the application of fuel oil, but a greatly increased efficiency per barrel. On the north, Seattle, Spokane, Tacoma, and Portland are well advanced in their municipal improvement projects. Seattle especially has adopted a comprehensive scheme for harbor work, calling for an expenditure of $13,500,000 for this purpose within the next five years. As for private enterprise, terms of mere millions are inadequate to convey an idea of the scope or extent of the many undertakings in process of development. The Pacific Gas & Electric Company is adding 40,000 kilowatts to its generating capacity by the development of the Bear river water-power. The Pacific Light & Power Company will ultimately develop 120,000 horse-power at Big Creek, where work is now under way. In the north, power, railway, irrigation, good roads, and other development enterprises are of such frequent occurrence as to excite little or no comment, and there is no doubt that when the time of immigration begins to flow westward, the West will be ready. Come West, young man.

## Gasoline Consumption

Use of internal-combustion engines throughout the United States, and more particularly of those types using refined oil products for fuel, has been increasing so tremendously that a serious shortage of gasoline has resulted. This shortage is growing more acute every day. The largest contributing factor is undoubtedly the enormous increase in the use of the automobile. California has issued licenses for over 80,000 automobiles, of which probably 50,000 are still in daily use. The number of machines in use is exceeded only by the state of New York, while the daily aggregate increase is now in excess of 100 cars. A simple calculation brings out the enormous demand upon the world's production of gasoline made by the almost universal use of the motor car. The mileage per gallon of gasoline varies from about 6 for the heaviest and highest powered cars, to from 25 to 28 for the lightest, low-powered cars; the general average under all conditions will probably not exceed about 12 miles per gallon of gasoline. The average daily mileage for pleasure vehicles may be taken at about 25, which would make the daily average consumption of gasoline for automobiles alone in the state of California not less than 100,000 gallons, based upon the assumption that there are 50,000 cars in daily use. This amount is increasing at the rate of over 200 gallons daily. The general average of Pennsylvania oils produces about 16 per cent gasoline, 50 per cent kerosene, 15 per cent lubricating oils, and 19 [illegible]

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cent residuum or waste, while the California oils produce only 3 per cent of gasoline, the other products being 37 per cent kerosene, 34 per cent lubricating oils, and 26 per cent asphalt, residuum, and waste. Thirty years ago gasoline sold for 2 cents per gallon, and was so little used that enormous quantities were burned in the open air at the refineries to furnish storage room for kerosene and other distillates. The price at which gasoline is sold to the consumer in California at the present is from 18 to 20 cents per gallon, and the worst is yet to come. Mr. D. G. Schofield, president of the Standard Oil Company of California, says that the price of gasoline will continue to rise if the demand increases in the same ratio as it has during the past two years. Of the total storage of oil in California at present—namely, some 45,000,000 barrels—36,000,000 is unfit for the production of gasoline, while not one pint of gasoline can be produced from the 21,000,000 barrels of oil now held in storage in California by the Standard Oil Company. The local demand has become so great that the supply produced by refining California oils is entirely inadequate, the Standard company having to resort to shipments of gasoline from the Eastern fields to supply consumers. It is not surprising, under these circumstances, that men who are in touch with the situation are eagerly searching for means of relief. A great deal of development has taken place comparatively recently in the design of engines suitable for burning the lower grades of fuel. Some excellent work has been done in perfecting a carburetor suitable for the use of kerosene as a substitute for gasoline or engine distillate, while engines of the Diesel type are commencing to create a widespread interest throughout the entire world. Although early applications of the gas producer in connection with California oil were not productive of good results for operating internal-combustion engines, recent developments along these lines have proved very much more satisfactory, and it is altogether likely that they will find an increasing use in California and the country tributary to the California oilfields. In the meantime, attention has been turned to the vast quantity of natural gas which has been allowed to go to waste in the oilfields for lack of a market. The Midway Gas Company, however, is at present installing a plant for piping natural gas from the Midway fields to Los Angeles for domestic purposes, while two companies—the Purity Gasoline Company of Santa Maria, and the Pacific Gasoline Company of Brea—are producing a good grade of gasoline from natural gas by means of air-compressors and condensers for after-cooling. It is stated that the natural gas produced by the Rice Ranch Oil Company furnishes approximately 2½ gallons of gasoline per 1000 cubic feet of natural gas, the total output of gas from the wells being approximately 2,000,000 cubic feet daily. While all natural gas is not suitable for the production of gasoline, there is no doubt that there is a promising opportunity for profit by investigating and developing this method of producing gasoline.

The enormous demand at present with no perceptible diminution should furnish sufficient incentive to interest capital and convert what is now practically a waste by-product of oil production into a means of increasing the wealth of the state and incidentally that of the men who undertake its development.

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# REVIEW OF THE MONTH

ATTEMPTED assassination of Colonel Roosevelt at Milwaukee on October 1 is a sad commentary on our boasted civilization. Attacks due to partisan politics inspired by the heat of the political campaign undoubtedly had their share of influence in supplying a motive to a weak mind. Foreigners view American campaign methods with profound wonder, and it is indeed difficult for any other than a native-born American to understand that the hard names and personal abuse that are employed so freely in the effort to influence voters are applied in a Pickwickian sense only, and that when the campaign is over the victor is congratulated by the vanquished and every one goes about his business.

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ACTION of the Standard Oil Company in declining to purchase any more crude oil below 18° Baumé is another blow to California oil producers. Some fifty-five companies operating in the Midway, Coalinga, Kern River, and Maricopa districts are affected by this ruling, which renders practically useless for the time being a monthly production of more than 700,000 barrels. This decision is undoubtedly due to the enormous production of low-gravity oils and the temporary failure of the demand to keep pace with the supply. The promised increase in price has not yet been forthcoming, and the only grain of comfort that may be extracted from the situation is that limiting the production is the only way of relieving the market congestion, and that the sooner this is done the sooner production may recommence, although it is doubtful whether the producers affected will be able to see it in so philosophical a light.

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COUNTER PROPOSAL of the Spring Valley Water Company to sell its property to the city of San Francisco for the sum of $38,500,000, providing it be permitted to retain some 2300 acres of land at Lake Merced, and including further provisions, as summarized in the October issue, has been rejected. The city officials take the position that the utility of Lake Merced for emergency water-supply throughout the dry season would be seriously impaired by the development of so large an acreage of the surrounding lands for residential or other purposes. It appears that the strip of land around the lakes, which the water company proposed to let the city have, is quite narrow, in some places being only 100 feet in width, and that no plan was submitted for protecting the water in the two lakes from contamination. Appraisal of the land at Lake Merced, which the company desires to retain, indicates that it has a far greater value for residential purposes than as a watershed. The construction of the Twin Peaks tunnel would render it not only available, but very desirable for villa sites, while the value of the lakes themselves as a source of water-supply has been seriously questioned, and, in fact, it is generally agreed that their chief value would be as a source of reserve or emergency supply in case of unusual necessity. The city has asked for the inventory and appraisal of the Spring Valley Water Company's



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property, made by J. G. White & Company, in order that it may be analyzed by the city engineer and the Water Advisory Board with the idea in view of finding some alternate proposal that would be mutually agreeable. It is considered that there is still a possibility that the city officials and the water company may arrive at an agreement that will be satisfactory to both parties.

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PRESENT transportation conditions in San Francisco and vicinity are the subject of a report by Mr. Bion J. Arnold supplementing others along the same lines that have been previously discussed in *Western Engineering*. Mr. Arnold's conclusions are so clear and logical as to be characterized as plain common-sense; so called, perhaps, because it is so uncommon. An interesting feature of the report gives an extremely simple reason for the unusual growth of the transbay cities that has taken place during the past five or six years. Mr. Arnold's time-zone map of San Francisco reveals the peculiar situation that, although the greater portion of its area could be reached within thirty minutes from the business centre by improved methods of transportation, yet at the present time only about half of its area has been developed. On the other hand, the daily migration of business population across the bay has no parallel in the United States with the exception of New York City. The superior transportation facilities offered by the splendid suburban services maintained by the Southern Pacific Company and the Oakland Traction interests, in marked contrast to those offered by the car lines within the city of San Francisco, are beyond a doubt the chief contributing factors in these conditions. The high cost of transportation down the peninsula has thus far proved an effective barrier against any rapid growth in this direction, and the five-cent commuter fare reaching the north of Berkeley is contrasted with thirteen and one-third cents for the same time-distance down the peninsula. Mr. Arnold states that rapid transbay suburban expansion along these lines cannot continue, as is indicated by the fact that the probable limit of quick transit has been reached by a development in electrification which finds no parallel in this country. As the fare could not conceivably be any lower, the filling up of the suburbs will tend to determine the future limits of transbay settlement. The keynote to the situation is indicated by the statement that transportation must precede settlement of any territory. The residents of San Mateo county have recently held several conferences with the officials of the Southern Pacific Company in an effort to induce them to lower the rates to the various suburban towns on the peninsula, making the plea that such a course would redound as much to the financial benefit of the railroad company as it would to the commuters individually, for the reason that a suitable lowering of rates would undoubtedly be accompanied by a large increase in commuter traffic and a consequent decrease in cost per capita for transportation. Another interesting condition shown by Mr. Arnold's report is that the people of San Francisco are addicted to the riding habit. The earnings per capita from transportation are the highest of any city in the country and almost twice as high as the average city, even exceeding Los Angeles in this respect. The daily transbay commuters to and from San Francisco comprise fully 23 per cent of the population of San Francisco,

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which results in earnings per capita as high as $18 to $20, as against $10 to $12 for the average American city of moderate size. The idea that the prevalence of winds and fogs in Richmond and Sunset districts are responsible for the delayed development of these sections is denied. The only reason is the absence of adequate service from utilities, particularly transportation and water. The past two years have signalized the civic awakening of the city of San Francisco, and whatever justice there may have been in the various criticisms that have been made from time to time concerning the city's lack of progressiveness, there is no doubt that this is a thing of the past and that the next five years will see remarkable changes.

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WHILE the California oil industry is suffering from an overproduction of the heavier grades of oil, reports from abroad indicate that the Russian naphtha industry is in a very unfavorable condition and the old Baku area is becoming exhausted. The shortage is becoming more and more apparent as the years go by, while the reports for 1911 show the lowest output for many years. In 1909 the total output was 490,000,000 poods (pood = 36.11 pounds); for 1910 the output was 488,000,000 poods; while for 1911 the figures reached the low mark of 427,000,000 poods. This nearly reaches the previous low mark of 1897, which was 422,000,000 poods. The shortage is partly covered by production in neighboring fields which brought the total output of naphtha in European Russia for 1911 to approximately 554,000,000 poods as compared with 594,000,000 in 1910. Astrakhan, the principal distributing centre of naphtha product, has received 269,900,000 poods, as compared to 296,300,000 poods in 1910, and 279,300,000 poods in 1909. Apparently the decrease in the quantity of naphtha brought to Astrakhan was not considerable, and taking into account the 75,000,000 poods of liquid fuel on the interior market on April 1, 1911, it is obvious that there was a supply of 344,900,000 poods of naphtha to meet the demands for liquid fuel in Russia during the year 1911-12.

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THE Oil Engineering Exhibition held in London in September has thrown an interesting light on the European development of the Diesel engine. Mr. C. Lakin Smith read a paper dealing with the application of this type of engine for marine and stationary purposes and has given some extremely interesting data as to the progress made in these directions. Mr. Smith states that engines of the Diesel type as large as 7200 horse-power are now being built in six-cylinder units of 1200 horse-power each, and that manufacturers have stated that they are prepared to accept orders for 9000-horse-power engines, which will consist of six cylinders of 1500 horse-power capacity each, while experimental work is now in progress looking toward the development of engines of 2000 horse-power per cylinder. There is no class of work abroad today in which the oil engine in some form or another is not represented; even railway work is included, as an experimental Diesel locomotive of 1000 horse-power and a rail motor of 2000 horse-power are already accomplished facts. Another interesting application of this type of prime mover is in the operation of canal boats. On the Grand Canal Company's system in Ireland there are now 48 barges fitted with crude-oil engines, while there are a large number in use and

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under construction for operation on various canals in England. Ordinarily a barge 70 feet in length and 17-foot beam would use a 15-horse-power engine which would enable the barge not only to propel itself, but to take two other barges in tow. Taking into consideration the additional cargo capacity available, ranging between five and seven tons, it is a safe assumption that the oil-engine can be employed at one-third the cost of a steam-engine and has a further point in its favor that neither constant nor skilled attention is necessary. Mr. Smith has given the following interesting comparison of the cost per horse-power-hour of steam, gas, and oil-engines, up to 1000 horse-power, based upon British conditions in central-station service:

| | Pence. | Load-factor. |
|---|---|---|
| Steam ..... | 0.45 | 14.7 |
| Gas ..... | 0.43 | 15.3 |
| Oil ..... | 0.25 | 14.3 |

FERRO-CONCRETE is finding many new uses, one of the most interesting of which is in the construction of a pontoon recently completed and launched at Irlan, England, by the Manchester Ship Canal Company. The vessel measures 100 feet in length by 28-foot beam and is designed to carry heavy pumping engines and a boiler plant. Notwithstanding its size, and the heavy load it is designed to carry, the pontoon is of slender construction and consists of a lightly-built frame inclosed by a shell only 3 inches thick. Its makers claim that it is not at all liable to fracture, although many opinions have been expressed to the contrary. This is the first vessel designed with a series of independent water-tight compartments which are accessible only by hatches or manholes from the main deck. This feature is of special interest at present in view of the recent inquiry into the loss of the *Titanic*, in which attention was called to the insufficiency of transverse bulkheads fitted with closing doors. The pontoon is intended to be unsinkable from the effect of any collision, as the interior hull is protected by a complete series of water-tight tanks which are in turn inclosed by the exterior hull. Interior of the pontoon is composed of one large compartment occupied by coal bunkers, stokehold, and boiler-room, and four smaller compartments formed by longitudinal and transverse bulkheads for use in connection with the pumping and other machinery on the decks above. This illustrates the method by which the principle of water-tight compartments has been carried out even in the interior of the vessel. There are also six independent water-tight compartments on each side of the pontoon and two large compartments of the tank type between the compartments at either side. It will be seen that the narrow portion of the vessel is surrounded by a series of 16 water-tight cells, all of which might be broken or destroyed without danger to the interior of the vessel, which itself is subdivided into five water-tight compartments. The pontoon has three decks in all, one of which is formed on the flat bottom, another extending above all the water-tight compartments with openings over the boiler-room and elsewhere as required, and the third is an upper deck carrying pumping machinery in addition to stores of various kinds. The vessel will carry about 100 tons of boiler, engine, and pumping plant, 40 tons of coal, and approximately 50 tons of water ballast. Construction was commenced in August 1911 and completed in March 1912.

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# The Internal-Combustion Engine in Central-Station Service

By J. W. WHITE*

THE last decade has marked a revolution in the type and development of the central station prime mover. With the exception of hydraulic power, the steam unit is the dominant factor in central-station service of today. It is also true, however, that the last ten years has seen the internal-combustion engine grow from an insignificant beginning to a place equally important in the industrial and agricultural development of our country. In fact, it is acknowledged that the aggregate horse-power of all the internal-combustion engines now in use in this country (including automobiles, motor trucks, farm application, and industrial service) exceeds by far the total horse-power of all our central stations, railroad locomotives, and industrial steam-plants. That the internal-combustion engine has already entered the central-station field of service is already acknowledged, and that in the near future it will be a successful competitor of the steam turbine, is a foregone conclusion. While the steam turbine will probably hold its own where the size of units is 5000 kw. and larger, nevertheless, for railway, industrial, marine, and central-station service (excepting plants serving large cities) the internal-combustion engine will be the prime mover of the power world before another ten years will have elapsed.

The early development of the internal-combustion engine has taken place along the line of least resistance. Gasoline was used, as it is more easily vaporized than any other commercial liquid fuel. While gasoline has brought forward the development of this type of prime mover more rapidly than if any other fuel were used, it delayed the arrival of the period of unquestioned economy. Inasmuch as gasoline forms between 3 and 4% of the total volume of crude oil, its use as a fuel universally applicable for power generation is necessarily restricted. Kerosene, distillates, and oil from 28 gravity down, form about 40% of the total volume of the crude oil, and about 92% of refined fuel, and must necessarily constitute the fuel-supply for the internal-combustion engine of the future. It is evident, therefore, that only such prime movers as can use these fuels commercially will be successful competitors of the steam turbine in central-station practice. At present the Diesel and the producer-gas are the only two types of internal-combustion engine which will successfully handle such fuels, broadly classified as 'power oils.'

The Diesel type of engine can use oils as low as 22 gravity, which are burned directly in the cylinders by being injected under high pressure at the proper point in the stroke cycle. In

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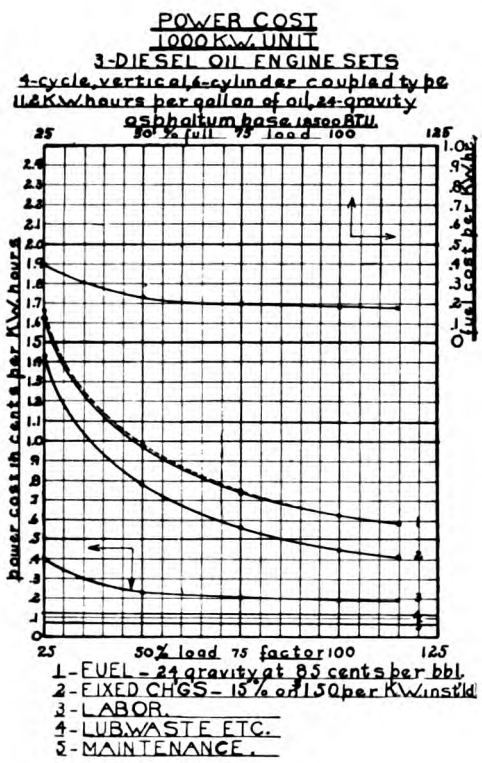
large units this type of engine has at present probably the highest thermal efficiency of any commercial prime mover. It has the disadvantage, however, of requiring a special refined fuel-oil. Diesel engines are usually built vertical and operate on four-stroke cycle with a multiplicity of cylinders. The high compression and high temperatures necessarily involved, together

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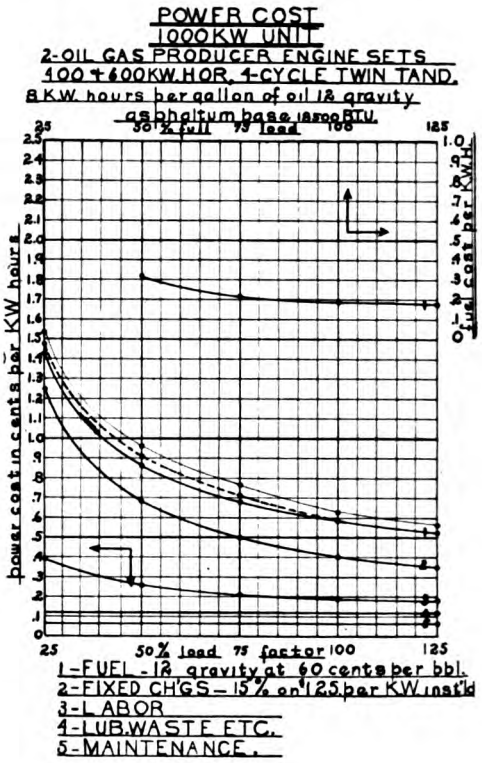


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with the multiplicity of cylinders and bearings, call for the highest class of construction, which results in an engine of high first cost, although of remarkable economy. The producer-gas engine, however, while of somewhat lower thermal efficiency when operating in conjunction with a gas-producer using crude oil as fuel, is as commercially successful as the Diesel type of Corliss engine does in the steam-engine field. There are four vital features in the choice of prime movers for a central-station plant, namely: reliability of service, thermal efficiency, capital invested, and maintenance. All other details in this connection are dependent on these four prerequisites, and therefore each and every type of prime mover should be compared in terms of

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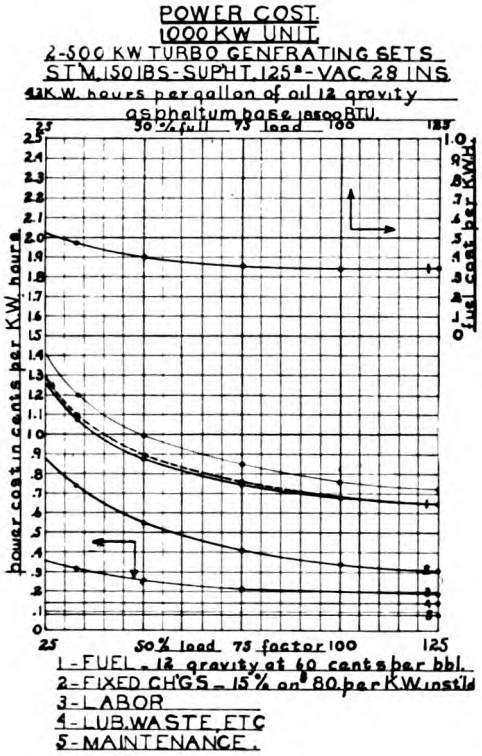
the above essential requirements.

**Reliability.**—The steam-plant is of well known reliability and needs no discussion. While it is true that the steam turbine itself is capable of longer operating periods without shut-down than the steam-engine, a high vacuum must be maintained, which brings up




CURVE No. 3.

the maintenance, and to a certain extent decreases its reliability, so that in the long run the steam-turbine plant has but slight superiority from a standpoint of reliability of operation as compared to the steam-engine. The Diesel engine operating on California oil has not as yet proved its reliability to the degree that the steam plant has attained or the producer is capable of showing. More continued service should be given by the engine of low compression, as the mechanical strains are less, temperatures lower, and the safety factors higher, while an engine in which the oil is burned direct in the cylinder must, on account of its peculiar design and characteristics, have high compression and a multiplicity of cylinders. Therefore, in the large sizes, it would naturally be built in the vertical plane, which does not give assurance of low cost and reliability. That the producer-gas engine applied to central-station service is reliable has already been demonstrated. The United States Steel Corporation has in service at its Gary plant over sixty of these engines, of 3500 to 4500 hp. each. On a recent visit to Gary, I was informed that in the case of one of the units, which included seventeen 4500-hp. engines driving electric generators, there had been no shut-down of an engine for over two months, except for one hour every Sunday for inspection. The other units were giving comparatively the same service.[1]

The Charlotte Electric Railway Co., of Charlotte, South Carolina, has installed two 540-kw. horizontal twin-tandem engine-sets.[2] Operating records show, and the management states, that electrical trouble have been more annoying than engine troubles. From daily reports during the year of 1909, a total interruption of service due to gas-producer and engine troubles is given at 2 hours and 45 minutes. The Peerless Oil Co., of California, has two gas-engines of the single-tandem type of 400 and 300 hp., respectively, driving air-compressors, and from their reports it appears that continuous oper-

[1] In this same plant there were two steam turbines, one of which was shut down for repairs, and had been out of commission for two months.

[2] See *Proc.* A. I. E. E., 1910, Vol. XXIX, page 429.

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ation has been secured from these engines of 160 consecutive days of 24 hours each. It is evident, therefore, that as far as this type of engine and auxiliaries are concerned, their reliability of service is equal, if not superior, to the steam unit.

For the past six years a number of patents have been issued and producers designed and built to operate on California crude oils. The results have demonstrated that the crude-oil producer has been commercially perfected so that it can and does operate continuously, without tar or lampblack by-product. Such operating achievement must claim the admiration of the engineering profession, and indicates a greater reliability than the steam boiler, which is subject to scale accumulation, materially affecting its efficiency and continuity of operation.

**Efficiency.**—It will be noted that in curves 1, 2, and 3, respectively, the fuel consumption and thermal efficiencies at full load are as follows:

| | Kw.-hr. per gal. of oil | B.t.u. per hp.-hr. | Therm. efficiency, per cent |
|---|---|---|---|
| Steam plant | 4.3 | 24,400 | 10.5 |
| Diesel engine | 11.2 | 8,800 | 29.0 |
| Gas-producer engine | 8.0 | 12,800 | 20.0 |

In the efficiency of the steam plant 10% was allowed for fall-off in economy as a basis of average efficiency. Stand-by, banking, radiation, and auxiliary losses have been figured at varying load factors. Evaporation was taken at 13 lb., full load water rate on turbines 17.1 per kilowatt-hour. It is believed that these will represent economies as high as can be expected in a plant of this size. The most economical steam-turbine units operating on the Pacific Coast at the present time (12,000-kw. capacity and larger) give a net operating service of about 6.32 kw.-hr. per gallon of oil, equivalent to 265 kw. per barrel of oil, or a thermal efficiency of 15%. The most economical Diesel installations in this country are actually below the economies given in this paper, namely, 11.2 kw.-hr. per gallon of 24 gravity oil, equivalent to 480 kw.-hr. per barrel of oil, or 29% thermal efficiency. Developments abroad point to such efficiencies in large units as would lead one to expect that under California conditions 12.7 kw.-hr. could be obtained per gallon of 24 gravity oil, or 533 kw.-hr. per barrel of oil, giving 33% thermal efficiency.

It is doubtful, however, whether California conditions will ever justify the construction of Diesel units in sizes above 1000 kw. for central-station service, on account of the fact that they will necessarily carry the small day load. If larger capacities are required, units of a size approximately as above will be duplicated. At the present the crude-oil gas-producer and engine are capable of commercial development in sizes up to and including 5000 kilowatts.

Under actual load conditions, a fuel consumption of 10.4 kw. per gallon of oil has been obtained, namely, 435 kw. per barrel of oil, or a thermal efficiency of 25.3%. In the near future it is expected that an economy will be obtained equivalent to 12 kw. per gallon of crude oil, namely, 503 kw.-hr. per barrel of oil, or a thermal efficiency of about 29 per cent.

**Costs.**—Inasmuch as the first cost of the steam-engine is a more dominant

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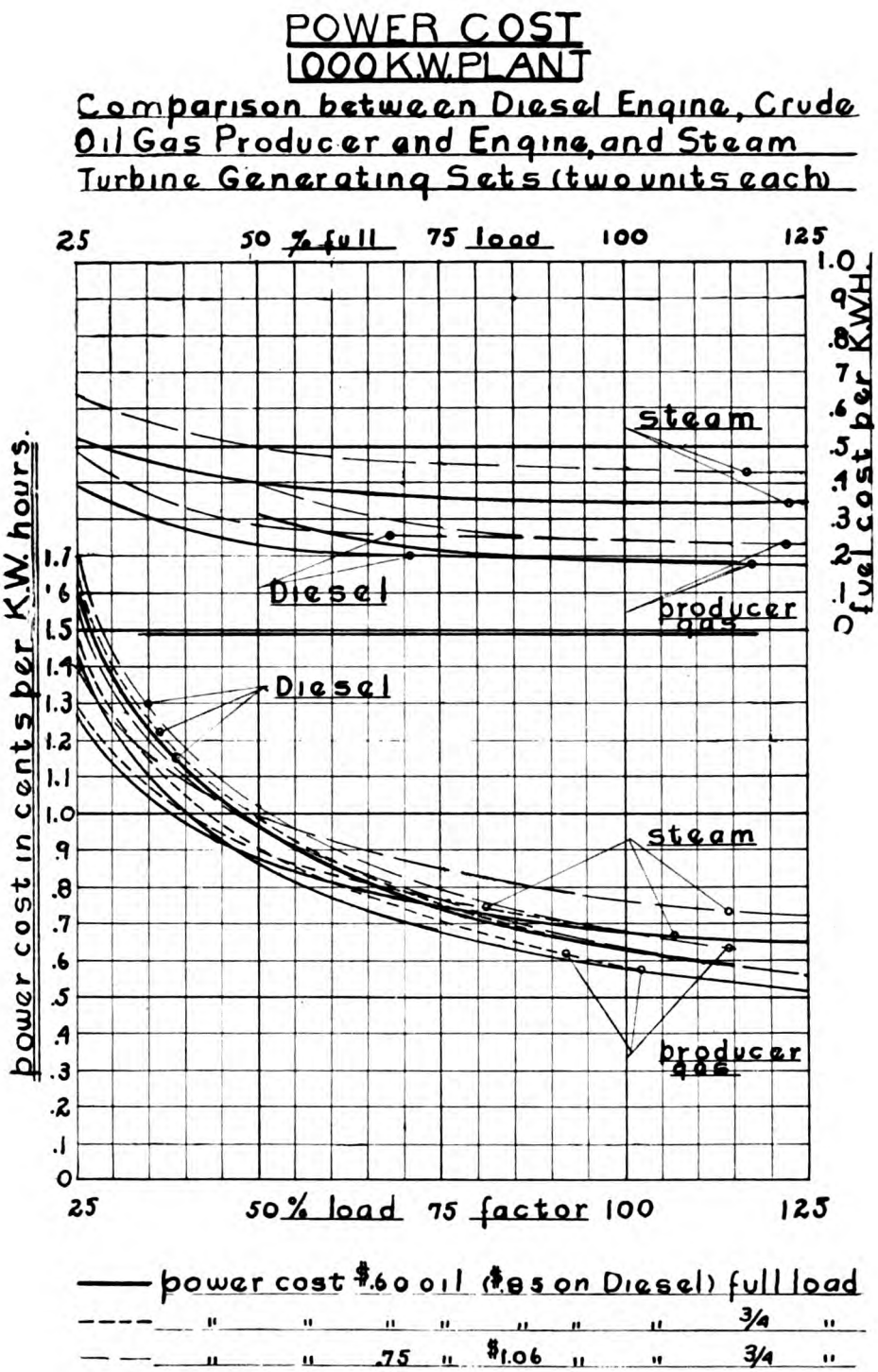


CURVE No. 4.

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influence in the choice of a steam-driven prime mover than a slightly increased economy in small-sized units, present central-station practice seems to compel the use of steam turbines almost exclusively. In this paper I have assumed for a basis of comparison a central station of 1000-kw. capacity. Neglecting buildings, the total cost per kilowatt of all machinery erected on foundations in a plant of this size would be approximately as follows:

| | Per Kw. |
|---|---|
| Steam plant | $ 80.00 |
| Crude-oil producer | 125.00 |
| Diesel engine | 150.00 |

**Maintenance.**—The depreciation of a steam plant while idle is acknowledged to be considerably in excess of that of the internal-combustion engine. The attendance for the latter, while having no direct bearing on maintenance, is accordingly reduced, but to what extent has not been accurately determined for Pacific Coast service. The only information that can be secured is from foreign experience and the operation of Eastern units, and even this is very meagre. The maintenance of the Diesel unit, however, is acknowledged to be considerably in excess of any other commercial type of internal-combustion engine. This is accounted for by its high compression and consequent high internal strains and temperatures, giving low safety factors and a high centre of gravity, together with a multiplicity of bearings which are hard to keep in alignment. In this comparison, certain definite charges have been made for maintenance, labor, and station supplies, which are approximated as closely as possible from reliable information on hand, and which, if not absolutely correct, have very little effect on the total power cost, as they form but a small portion of the total fixed charges. While there is no doubt that, under certain conditions, any type of prime mover may have a distinct advantage, each individual set of conditions varies so that it is hard to make a general rule covering the selection of such apparatus. I have assumed a central station having a capacity of 1000 kw., upon which to base calculations, because a plant of smaller size would be excessive in labor charges, while a central station of larger capacity would not vary greatly from the assumed charges to cover the plant in question. In the case of the steam unit, plenty of condensing water is assumed to be at hand for use in surface condensers. Curves 1, 2, and 3 show, respectively, power costs for each type of unit, plotted for each condition of load factor, and also on the same sheets are plotted the fuel cost per kilowatt for each type. Curve 4 shows a recapitulation of all of these charges. It will be noticed that on curve 4 the economy curve of the steam turbine is considerably higher than either the power-cost curve of the Diesel or the producer units, but that on account of its low fixed charges its economy does not fall off as rapidly as either type of internal-combustion engine on low load-factor, and it will be observed that at 75% load-factor its power-cost curve actually crosses that of the Diesel engine, and that at about 48% load-factor it crosses that of the producer-gas engine.

It will be noted that for the steam plant and the producer-gas engine, oil is figured at 60c. per barrel; while for the Diesel, oil is figured at 85c. per barrel. If the prices of oil are raised 25%, namely, to 75c. per barrel for the steam and producer-gas engines, and to $1.06 on the Diesel unit, the

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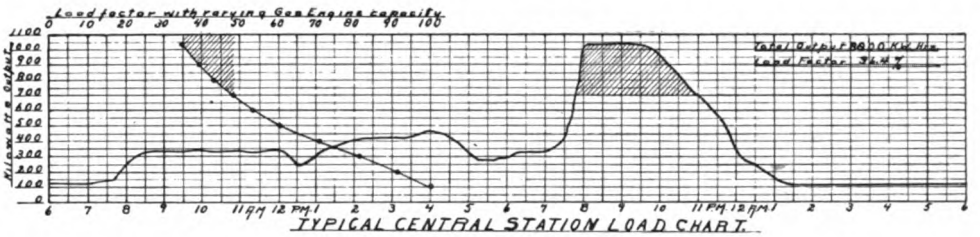
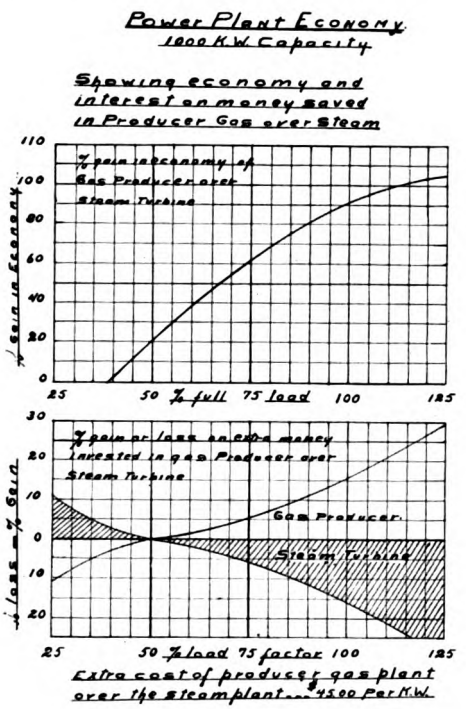
power-cost curve of the steam-engine does not cross that of the Diesel unit until a load-factor of 55% is reached, and that it does not cross the power-cost curve of the producer unit until a load factor of 42% is reached. A careful study of these curves indicates that the extra cost of the Diesel unit as a prime mover is justified, provided that the load factor is kept to at least 75%, and that the selection of a producer-gas unit is justified for load factors as low as 48%, and that, as the price of fuel rises, the comparison continues to favor the internal-combustion engines.




CURVE NO. 5

In stations of larger capacity there will be a slight change in favor of the steam unit, while in units of smaller sizes the economy of the internal-combustion engine would remain very nearly the same; and that of the steam unit would fall rapidly. This would indicate that, while for isolated and industrial plants the use of the internal-combustion engine is warranted, and in a number of cases preferable, its universal application to central-station service is not as likely on account of the fact that such service is usually accompanied by a low load factor, which averages from 35 to 40%. On the other hand, it indicates that the use of a composite plant will bring up the central-station economy to a marked degree. The first cost of the steam unit being low, its period of idle operation can be increased in preference to the producer engine, while the latter, having a higher first cost, should be run the greater portion of the time. From the power-cost curves submitted, it is evident that if a producer unit can be installed of such capacity that it will carry the day load at approximately its full-load rating, and allow the steam units to take the peak-load demands, a maximum of economy will be obtained.




CURVES NO. 6 AND 7.

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Curve 5 is a typical central-station load-chart, and was obtained by averaging a number of different station charts after having reduced them all to a maximum output capacity of 1000 kw. From this chart a load-factor curve is drawn showing the load factor of a generator of any output within the maximum. It will be noted that in curve 4 the power-cost curve of the steam plant is crossed by the Diesel-engine curve at 75% load factor, and at 48% load factor by the oil gas-producer engine. In curve 5 it will be observed that these two points in the load-factor curve indicate that the maximum station capacity allowed is 375 kw. for the Diesel and 700 kw. for the oil gas-producer engine. In the majority of cases it would appear that more than one internal-combustion engine is desirable, and careful study of these conditions indicate that the most economical composite plant should consist of two-thirds its rated capacity in internal-combustion engines, and the remaining third will be steam turbines. Curve 6 shows the percentage of gain in economy by the oil gas-producer unit over the steam turbine for fuel only, basing the steam-unit economy as unity. Assuming that the oil gas-producer set costs $45 per kilowatt more than the steam plant, curve 7 gives the percentage interest on the extra money invested, with the respective plants operating at varying load factors, the steam-plant investment as unity. In this curve the superiority of the oil gas-producer engine at high load factors, and the net economy of the steam plant on low load factors, is clearly indicated, showing conclusively the advantage of a composite plant on central-station service.

The exhaust gases of the internal-combustion engine will evaporate approximately 2 lb. of water from and at 212°F. for every brake-horse-power of internal-combustion engine installed. In the average plant, this evaporation will supply sufficient steam to generate 10% of the internal-combustion engine capacity, which will be equivalent to 6.6% of the total capacity, or practically 20% of the output of the steam portion of the plant. It is at once evident that this exhaust heat will take care of stand-by, banking, and radiation losses on the steam turbine, and materially raise its overall economy while in service, thus cutting down the power cost approximately 10% at 40% load factor.

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# Significance of Panama Canal Legislation*

By WILLIAM R. WHEELER†

NO greater piece of constructive legislation has been adopted by Congress in many years than the Panama canal bill signed by President Taft, August 24. The bill provides for the future administration of the canal, the government of the canal zone by a governor to be appointed by the President, and establishes a judicial system for the zone. Authority is given the President to establish dry-docks and repair shops; to provide coal and other materials; labor, repairs, and supplies to be supplied at reasonable prices to passing vessels. It prescribes a maximum and a minimum, within which tolls to foreign-going vessels are to be fixed by the President, stipulating that no tolls shall be charged to American vessels in the coastwise trade. It amends the navigation laws to the extent that foreign-built ships (not over five years old), owned wholly by citizens of the United States may be given American registry to engage in foreign trade only. It amends the tariff laws to the extent that ship-building may be imported free of duty for construction of vessels for either coastwise or foreign trade. It amends the interstate commerce act by making it unlawful for transcontinental railways to operate vessels through the canal in the coastwise trade, and further, makes unlawful the operation after July 1, 1914, by a railroad company of a water line elsewhere which is in competition with its rail line, unless the railroad company can satisfy the Interstate Commerce Commission that its water line "is being operated in the interest of the public and is of advantage to the convenience and commerce of the people, and that such line neither excludes, prevents, nor reduces competition on the route by water under consideration," in which case the railroad-owned water-carrier becomes subject to the 'Act to Regulate Commerce' exactly as the rail line itself is subject to said act. The bill further amends the interestate commerce act by giving the Interstate Commerce Commission jurisdiction over all joint rail and water transportation and the carriers, both rail and water, engaged therein, and empowers the Commission to enforce physical connection between such carriers, further empowering it to establish through joint rail and water routes and rates, proportional rates over the rail portion of such route, and enforce on the part of railroads equal treatment toward all foreign-going steamship lines. Lastly, the bill amends the Sherman anti-trust act in that it excludes from the canal any vessel "owned, chartered, operated, or controlled by any person or company which is doing business in violation of the provisions of said Act."

*Address before Commonwealth Club, San Francisco, September 1912.

†Manager Traffic Bureau, Merchants' Exchange, San Francisco.



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The bill has been criticized by its enemies because it embodies legislation which, it is alleged, is foreign to its title. Such criticism is puerile. The real question is whether or not the various provisions found in the bill are good or bad. They are undoubtedly all good, and the question of whether or not any or all of them belong in the canal bill is of no consequence, for they will be just as much the law of the land in one statute as in another. It is but natural that during the extensive hearings covering the period of more than seven months in which the canal bill was incubating, needful legislation applicable elsewhere than to the canal was made manifest. The canal bill afforded the opportunity for the immediate passage of legislation which, while bound to be adopted eventually, might otherwise not have been accomplished for years to come.

In order that the origin of the provisions for free tolls to American vessels in the coastwise trade and the inhibition of the operation through the canal of vessels in the coastwise trade by trans-continental railroads, found in sections 5 and 11, respectively, of the Panama canal bill may be fully understood, I will briefly sketch the history of events which culminated in these provisions being incorporated into the statutes of the nation. In the first annual report of the Traffic Bureau of the Merchants' Exchange, now the San Francisco Chamber of Commerce, issued in 1909, is found the following:

> In order that San Francisco and other seaport cities may receive the full benefits accruing to such location, an amendment to the interstate commerce act should be adopted, making it unlawful for railroad companies to own, control, or be interested in, either directly or indirectly, or maintain contractual relations or agreements with, competing steamship or steamboat or other lines of vessels. Such ownership or control is today exercized over most of the steamships operating on the Great Lakes and along the Atlantic coast. It is not necessary for us to go beyond our own immediate horizon to find examples of like nature in our ocean and river transportation. It is obvious that the purpose and effect of railroad ownership and control of competing routes is to maintain rates far above the natural water level, or those which would obtain if competition on the water were permitted to exist. The question of profit to be made by such water lines is to them secondary consideration, the primary consideration being to protect the rates of a parallel rail route. Therefore there is, on the one hand, no incentive for the operation of such water routes to make profit or to increase business to a profitable volume by reducing rates of the water line to a reasonable figure, and, on the other hand, the existence of such railroad-owned line is a constant menace to a private owner who would otherwise put on steamships to be operated in good faith and at rates which would attract business from the rails. Until the rates of water carriers are placed at a true water level by being based upon the cost of water carriage instead of upon the rates charged by the railroads, San Francisco cannot come into the full enjoyment and benefits of that heritage which is hers.
>
> San Francisco, in common with other Pacific coast seaports, is expecting great benefits from the completion of the Panama canal, chief among which is expeditious and regular steamship service between San Francisco and the Atlantic seaboard at true sea-level rates, which will not only have the effect of reducing the cost of distribution to the California producer, but will, at the same time, lower the cost of many of the articles which he consumes, thus, in the last analysis, materially increasing his purchasing power. Will such benefits be realized if the railway interests are permitted to operate steamships between, say, New York and San Francisco, occupying the field to the exclusion of independent owners, and maintaining artificially high rates for the protection of the transcontinental railroads? No independent owner would dare to engage in competition with such a line, no matter how invitingly high the rates might be, well knowing that rates would be dropped to an unprofitable figure upon the establishment of a new line, to his ultimate financial undoing. This is not a theory, as every steamship owner will attest. Experience of the past is the prophecy for the future.
>
> Profitable export trade can be built up only on a profitable home market. Likewise the free and untrammeled development of coastwise traffic to the fullness of its possibilities should be the first step in line with the establishment of a foreign-going American merchant marine.

In the Bureau's report for 1910 occurs the following paragraph:

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Your manager's last annual report called attention to the necessity for an amendment to the 'Act to Regulate Commerce,' making unlawful the ownership or control by railroads of competing water lines, and pointed out the importance of the adoption of such an amendment in view of the approaching completion of the Panama canal. It is gratifying to announce that this was brought to the personal attention of President Taft, who expressed his appreciation of the necessity for the proposed amendment and promised that he would lend his hearty coöperation toward bringing about its adoption by Congress.

I now quote from the Traffic Bureau's report for 1911:

In the Interstate Commerce Commission's 'Reno Decision,' written by Commissioner Lane, appears the following significant paragraph:

The coast cities—those that have direct access to the ocean, cannot be materially injured by the policy of the law we have herein considered. They are rendered secure as entre-pots of commerce by the presence of the ocean, so long as they choose to avail themselves of its advantages. There is much reason in this record, too, for the belief that they have at times chosen to forego these advantages in the expectation that they would be made secure by the rail carriers of a large distributing market in the interior. With the introduction of a policy which removes from these interior points in some degree the disadvantage under which they have suffered with relation to Eastern points of production, it will become a matter of moment to the coast cities to avail themselves fully of the ocean as well as develop industries upon the Pacific coast itself which will compete with the industries of the East for the interior trade. That which has been done in the Middle West within a generation may certainly be accomplished upon the Pacific coast, so that there may come about a competition between real producing markets as well as competition between jobbing houses.

There is much ground for the Commission's criticism of the failure of San Francisco to take advantage of her water facilities in the past. Our water routes should be developed and the service improved. To this end, the Bureau, ever since its organization, has been unrelaxing in its efforts, with the result that the freight movement by way of Panama, both east-bound and west-bound, shows astonishing increases since the Bureau first took up with the authorities at Washington the opening of this route to unrestricted activities. The following table shows freight movement by way of Panama for the past three fiscal years, ended June 30, and tells its own story:

| | 1909. | 1910. | 1911. |
|---|---|---|---|
| West-bound | 37,909 | 46,253 | 96,324 |
| East-bound | 8,700 | 33,405 | 115,483 |
| Total | 46,609 | 79,658 | 211,807 |

This demonstrates that San Francisco shippers are fast coming to the realization that they must use the sea, if they would profit by our city's seaboard location. The day has arrived when sea competition must be actual and not merely potential, if San Francisco is to come into her own as the great seaport of the Pacific.

In this connection it is proper to report that the Bureau was successful by petition to the President of the United States and Secretary of War in bringing to an end the ruinous freight war inaugurated by one of the Pacific connections of the Panama railroad against the other Pacific carrier. East-bound rates, San Francisco to New York, were cut from $8 per ton to $5 per ton: the latter, under present conditions, can hardly be considered a compensatory rate. It is not to the interest of San Francisco to have ruinously low rates which can be but temporary; what she wants are fair rates and the guarantee of permanency.

The freight war referred to emphasizes the necessity for such legislation as will prevent railroad-owned lines operating through the canal, as recommended by the President, and referred to elsewhere in this report. The Bureau, from the beginning, has been vigilant in its efforts to make the canal, when completed, of the greatest possible value to the shippers of this city and state. As pointed out in our last

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annual report, we brought to the attention of the President of the United States the necessity for an amendment to the 'Act to Regulate Commerce,' making unlawful the ownership or control by railroads of competing water lines, and pointed out the importance of the adoption of such an amendment in view of the approaching completion of the Panama canal. It is gratifying to note the appreciation by the President of the importance of such legislation as expressed in his message to Congress of December 6, 1910, which is incorporated in the resolutions adopted at a congress of the representatives of commercial bodies of Pacific coast cities, held in this city, October 2 last, through the invitation of the San Francisco Chamber of Commerce, at which this Bureau was represented. At this meeting the question of canal tolls was fully discussed; Senator Perkins and Congressmen Knowland and Hayes being present. The following resolutions were unanimously passed:

*Whereas*, The building of the Panama canal was undertaken by the people of the United States in pursuance of a great national policy, amongst other things, of providing for the national defense, opening up the shortest possible water route between the respective coasts of the United States and foreign countries, to provide through natural methods and to prevent monopoly of transportation, means for transportation between the various sections of the Union at the lowest possible cost, to build up and expand our commerce with foreign nations, and incidentally to encourage the upbuilding of a now decadent merchant marine; be it

*Resolved*, That it is the sense of this meeting that there should be no tolls charged through the canal to vessels coastwise flying the American flag; and be it further

*Resolved*, That we heartily approve of the legislation recommended by President Taft in his message to Congress of December 6, 1910, reading as follows:

"I cannot close this reference to the canal without suggesting as a wise amendment to the Interstate Commerce law, a provision prohibiting interstate commerce railroads from owning or controlling ships engaged in the trade through the Panama canal. I believe that such a provision may be needed to save to the people of the United States the benefits of the competition in trade between the Eastern and Western seaboards which this canal was constructed to secure."

In view of the fact that the question of tolls to be charged through Panama will beyond doubt be acted upon at the coming session of Congress, and the importance to the country at large of low rates of transportation, particularly on its productions, each member of the Bureau is urged to do all that he can to secure the adoption of the policy outlined in this resolution. Every charge made on domestic traffic through the canal will be a direct tax on the commerce of this country, and it is believed that united efforts can go far towards freeing domestic tonnage from any tolls.

The Bureau is at this time seeking to enlist the coöperation of the Atlantic and Gulf seaboard cities to the end that a petition, along the line of the above resolution, may be presented at the coming session of Congress. It is expected that a congress of all representatives of seaboard cities, including those situated on navigable rivers of the Middle West, will be called at Washington about December 1, for the purpose of discussing the above questions and presenting bills, along the lines indicated, to Congress.

Inasmuch as it is announced by President Taft that the canal will be open for the passage of vessels by July 1, 1913, no time is to be lost in putting ourselves in position to reap the benefits which can be derived therefrom.

By direction of the board of directors of the San Francisco Chamber of Commerce, the manager of its Traffic Bureau last January went to Washington authorized to promote legislation along the lines of the Chamber's resolutions. We succeeded in securing the coöperation of the leading commercial organi-

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zations of the Atlantic seaboard, including the Merchants' Association of New York and the Chambers of Commerce of Boston and Philadelphia, the representatives of which gave helpful testimony before the House and Senate committees. Former Senator Flint, in behalf of the Los Angeles Chamber of Commerce, appeared before the House Committee on Interstate and Foreign Commerce, which committee had charge of the bill in the Lower House. His testimony was particularly valuable, as he possesses a thorough knowledge of California's transportation conditions, not only through his long residence in this state, but through his chairmanship of the Senate committee on interoceanic canals while a member of the Upper House. Joseph N. Teal, general counsel for the Chamber of Commerce of Portland, Oregon, and through his life-long interest in water transportation, known at home as 'the Father of Waters,' made a splendid impression upon the Senate committee.

Opposed to us were substantially all the railroads of the country that operated vessels on routes competitive with their rail lines. These included the New York, New Haven & Hartford, New York Central, and Pennsylvania. They were represented by their presidents, vice-presidents, attorneys, and managers of their water lines. Heads of every prominent ship-building concern were also brought to Washington to testify in effect that only railroad companies build vessels nowadays, and, if inhibited through the canal or elsewhere, no ships are likely to be built, and, in consequence, they would have to close up shop, the ship-building industry of the United States would be ruined, and there would be no vessels to go through the canal!

We had the disadvantage of having the bill in unfriendly hands from start to finish. In accomplishing legislation, half the battle lies in the coöperation of the chairmen of the committees which have charge of the bill; without this, legislation is frequently 'put to sleep' or, in any event, as in this instance, made to drag. The chairman of the House Committee on Interstate and Foreign Commerce was rabidly opposed to our free tolls proposition, and, with regard to the inhibition of railroad-owned ships, believed this legislation should go over until next session, or, in any event, be taken out of the canal bill and made a separate measure. The chairman of the Senate Committee on Interoceanic Canals vigorously opposed both measures in committee and on the floor of the Senate, and fought them up to the very last minute when the final vote was taken. Had it not been for the tireless work of Mr. Knowland, in the House, and Senator Bristow, in the Senate, I doubt if we would have gotten action on these measures at this session, even if they were saved from defeat.

It will be observed that the measures for which the San Francisco Chamber of Commerce stood have been incorporated into the bill in their entirety. The inhibition of the operation through the canal of vessels controlled by transcontinental railroads is a guarantee of the free competition between independent owners which, taken in connection with the freedom from any toll charge to vessels in the coastwise trade, insures the distribution of our products and manufactures along the Atlantic and Gulf seaboards at the lowest possible rates. The influence of these rates will be reflected on rail rates, not alone to Atlantic and Gulf ports, but throughout the Middle West as well. Like low rates will necessarily be accorded west-bound traffic, so

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that our producers, who constitute the major portion of our consumers, will enjoy greatly reduced freight rates not alone upon what they produce, but upon what they consume as well. Low freight rates through the canal or rail rates influenced thereby will result not alone in an enlarged market for our products, but will leave in the hands of our people larger net cash results with which to develop the resources of our state.

It has been claimed by those opposing free tolls to our coastwise traffic that the charge for tolls would not affect freight rates, and, in any event, would not amount to more than 40 or 50c. an actual ton in case the charge was $1 per net register ton, as proposed. Both claims are fallacious. A steamship line operating through the canal could not be expected in all instances to fill its vessels to full capacity, therefore, it would necessarily be obliged to add to its freight rate sufficient sum to cover the toll charge as applied to their average carryings. Based upon the loading of the various steamship lines, operating out of Boston during the year 1910, it was conclusively shown at the hearings in Washington that to cover an assumed toll of $1 per net register ton, sums ranging from 95c. to $2.82 per ton would have to be added to the normal freight rates of the various lines serving that city. It is fair to assume that it would be found necessary to add no less amounts to the otherwise normal freight rates to cover tollage through the canal had Congress authorized the proposed charge of $1 per net register ton.

Now a word as to the alleged violation of the Hay-Pauncefote treaty by granting to our vessels in the coastwise trade freedom from tolls while charging tolls to foreign vessels. That such action is not in violation of the treaty has been conclusively demonstrated upon the floor of the Senate and the floor of the House and by various lines of reasoning. I am here reminded of the story of an attorney for the defendant in a criminal case who, when the case was called, moved for dismissal, stating that he had ten different reasons for his motion; one of which was that the defendant was dead. "In that case," interjected the court, "never mind the other nine; the motion is allowed." Therefore, I will, at this time, offer but one argument in support of my contention that the decision in favor of American ships in the coastwise trade in no way violates the treaty, and that argument is contained in the case of Olsen *v.* Smith (195 U. S., 332). An examination of this case discloses that on the question of discrimination it is on all-fours with the subject we are now considering. In that case the treaty with Great Britain provided that "no higher or other duties or charges shall be imposed in any ports of the United States on British vessels than those payable in the same ports by vessels of the United States."

The court held that this treaty was not violated by either the Texas statute or the Revised Statutes of the United States, section 4444, exempting coastwise steam vessels from the payment of pilotage charges. In that connection, speaking for the court, Justice White, now Chief Justice, said:

> Nor is there merit in the contention that as the vessel in question was a British vessel coming from a foreign port, the state laws concerning pilotage are in conflict with the treaty between Great Britain and the United States, providing that 'no higher or other duties or charges shall be imposed in any ports of the United States on British vessels than those payable in the same ports by vessels of the United States.' Neither the exemption of coastwise steam vessels from pilotage resulting from the law of the

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United States nor any lawful exemption of coastwise vessels created by the state law concerns vessels in the foreign trade, and, therefore, any such exemptions do not operate to produce a discrimination against British vessels engaged in a foreign trade and in favor of the vessels of the United States in such trade. In substance the proposition but asserts that because by the law of the United States, steam vessels in the coastwise trade have been exempt from pilotage regulations, therefore there is no power to subject vessels in foreign trade to pilotage regulations even though such regulations apply without discrimination to all vessels engaged in such foreign trade, whether domestic or foreign.

If a treaty with Great Britain providing that "no higher or other duties or charges shall be imposed in any ports of the United States on British vessels than those payable in the same ports by vessels of the United States," is not violated by an exemption in favor of our own vessels engaged in coastwise trade from payment of pilotage charges, it must necessarily follow that the Hay-Pauncefote treaty would not be violated by a similar exemption of our coastwise vessels from the payment of tolls at the Panama canal.

While the bill provides that "no tolls shall be levied upon vessels engaged in the coastwise trade of the United States," it does not specifically provide that tolls shall be charged to American vessels in the foreign trade. On the contrary, it assumes our right to differentiate or charge no tolls at all to such vessels, in that it authorizes the President to fix tolls that "shall not exceed $1.25 per net register ton, nor be less, other than for vessels of the United States and its citizens, than the established proportionate cost of the actual maintenance and operation of the canal." This makes it plain that under the terms of the bill the President may, if he sees fit, permit American vessels in the foreign trade to pass through the canal free of tollage. In the interest of the upbuilding of our foreign-going merchant marine it is to be hoped that he will grant such permission, provided, of course, that treaty rights are not violated thereby.

The people of California and the entire Pacific coast look to the Panama canal for the solution of their two great problems—transportation and immigration. The legislation herein discussed insures the effectiveness of the canal as the solvent of the first. As to the second, by natural process a large proportion of the great wave of European immigration which today rolls into the ports of our Atlantic seaboard, will find its way through the canal to this and other Pacific ports of the United States. This immigration will consist largely of men accustomed to working in fields of agriculture similar to those of California. These will afford an adequate supply of much-needed farm labor and in a comparatively short time, through their industry and frugality, they themselves will acquire farms of their own.

As a student of immigration, in the various European countries that I visited, I found that the greatest of all agencies for the promotion of immigration is the immigrant himself. If he finds conditions to his liking, he writes to his relatives and friends urging them to follow him. They, in turn, do likewise after arriving, so the endless chain is formed and the volume grows in a progressive ratio.

Through coöperation between our state and federal governments, the proper distribution of this immigration can be materially assisted. The California development board is doing a valuable work in promoting preparations for the reception and distribution of this new immigration, which will develop and till her now unoccupied lands and thus contribute to her prosperity and her citizenship.

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# New Highway System for King County, Washington

By J. R. MORRISON*

[Nowhere is the development of good roads receiving greater impetus than in the Pacific Northwest. The engineer of King county, Washington, has prepared a comprehensive scheme of road building that will add greatly to the attractiveness of his state and offer inducements to home builders and settlers. An exhaustive description of the system proposed is embodied in a report to the Board of County Supervisors dated September 5, 1912, which is presented below.—EDITOR.]

I HAVE prepared a map of King county, which accompanies this report, showing a system of main-trunk highways such as, in my opinion, will be required to give a comprehensive system. This proposed system will serve every section of the county capable of development with a trunk road. The mileage of the complete system is approximately 500, and of course cannot be undertaken as a whole at this time, but I have submitted it to show what will ultimately be demanded in order to intelligently select the most important roads for improvement under the proposed bond issue.

Assume that $1,000,000 is apportioned to city, engineering, right-of-way, and incidentals, that permanent highway fund yields $330,000 in 1913, $240,000 in 1914, $250,000 in 1915, balance of bond issue is $2,000,000, giving a grand total of $2,820,000, and that it will require three years in which to complete the work. The only roads which are permanently located and graded, with the fills properly settled ready to receive a permanent surface in 1913, are: the North Trunk road, 6 miles; the Bothell road, 3½ miles; state aid road No. 69, 3½ miles; or a total of 13 miles, which can be surfaced in 1913 with the permanent highway fund.

This will complete the North Trunk to the Snohomish county line, the Bothell road to Bothell, and the state aid road No. 69 to Pacific City, leaving one and one-half miles not yet graded to reach the Pierce county line to connect with the Pierce county road to Tacoma, which is not under construction. Also 1½ miles from the south boundary of Bothell to complete the Bothell road to the Snohomish county line to connect with the Snohomish county road to Everett which is almost completed.

There are projects which are now under way and which were intended to be completed with the permanent highway fund as soon as available. In addition to the above, we have three miles from Rainier beach to Renton which is ready to be surfaced and which could be undertaken in 1913.

All other existing or proposed roads would have to be re-located to a width demanded by present traffic conditions. These grades should by all means be allowed at least one year for settle-

*Engineer, King county, Washington.



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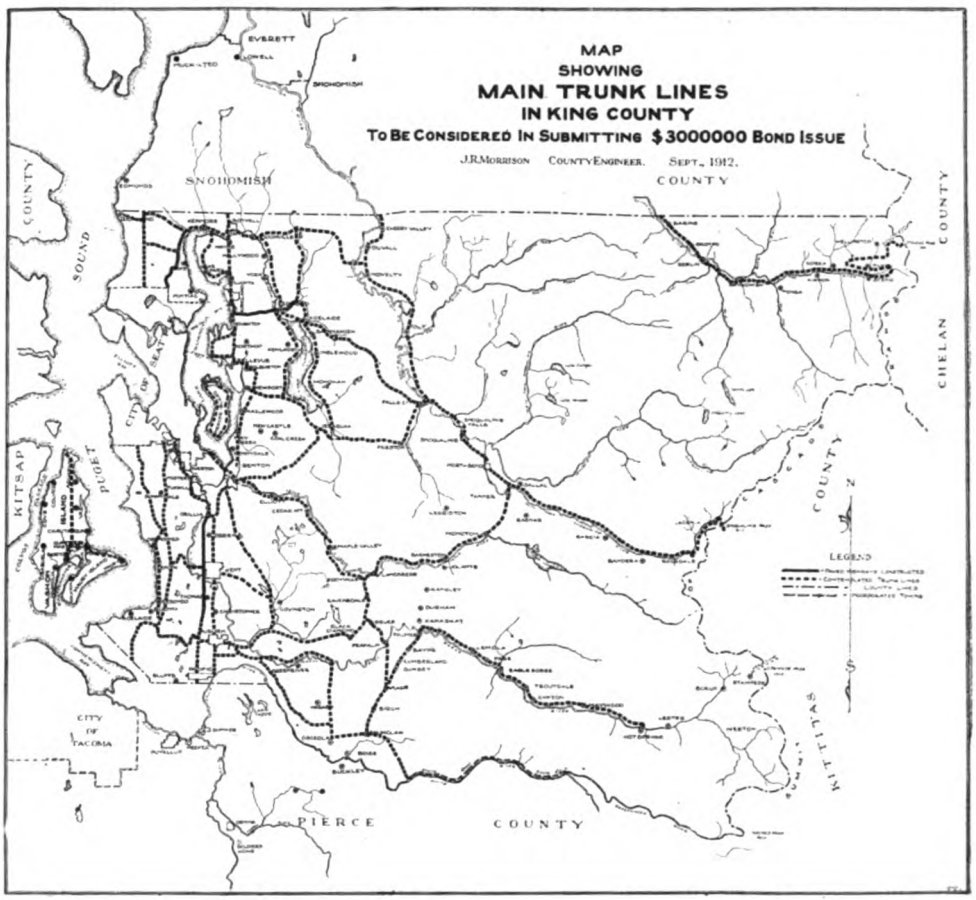
ment, and if any considerable fills are required they would be much better with two years settlement before being covered with an expensive surface. It would therefore seem to be the best plan, after deciding upon the particular roads to be improved under this bond issue, to rush the work of location and secure needed right-of-way, then let contracts for grading and give the roads a surface of gravel, which will afford a very fair road for use while waiting for the new grade to settle. If no trouble is encountered in securing the necessary right-of-way, this preliminary work could be completed and contracts let for construction early in 1913. The question of the class of road and its cost will, of course, control the number of miles which can be constructed, and may also influence to some extent the roads selected for improvement under the proposed bond issue.

Unfortunately, the time given to make this report prohibits detailed estimates on each road, but I can make a close approximation of costs by references to recent contracts for similar construction. A few years ago we were confronted by the advent of the automobile, which necessitated wider and better roads. Today we are facing a greater problem with the auto truck, and one which will gain upon us more rapidly and require wider and better

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roads than automobiles. Our grades should be widened to 30 ft., and the paved surface to at least 18 ft., in order to carry the traffic of the future. Grading 30 ft. wide, with necessary culverts, will average $7500 per mile. Graveling per mile will average $2500. Second-class vitrified brick laid 16 ft. wide with concrete curbs cost $22,000 per mile between Kent and Meredith. A surface 18 ft. wide would therefore cost approximately $25,000 per mile, with the same freight charges and cost of hauling.

I would respectfully suggest the following plan for expending the $2,820,000 which would be available for use outside of the city of Seattle, including the permanent highway fund for 1913, 1914, and 1915.

**Paved Surface.**—The North Trunk or Woodland Park avenue extension. The Bothell road to the Snohomish county line. The Seattle-Tacoma boulevard from end of present improvement to the Pierce county line. Extension of Rainier boulevard to Renton. Old macadam road from Georgetown to Orillia (this will have to be widened and paved within three years).

Re-locate, widen, grade, and surface with gravel or crushed stone:

North Trunk to Richmond beach.
Wayne road to Kirkland (waterfront).
Bothell to Snoqualmie river.
Redmond to Snoqualmie-Bothell road.
Cherry valley to Falls City.
Redmond to North Bend.
Redmond to Issaquah.
Kirkland to Renton.
Medina to Bellevue.
Renton to Issaquah.
Renton to Landsburg and Franklin.
Renton to Kent-Franklin road.
Renton to Orillia.
Issaquah to Falls City.
Youngstown to Pierce county line.
Auburn to Pierce county line.
Auburn to Enumclaw.
Auburn to Black Diamond.
Franklin to Veazie.
Enumclaw to Kanaskat.
Vashon Island.
Mercer Island.

This plan would give us one paved highway to Pierce county line, one to Renton, two to the Snohomish county line, and 215 miles of good gravel roads, permanently constructed, which could be surfaced from time to time as funds become available for that purpose. The only really permanent investment in a road is the grade or roadbed. Any form of pavement will wear out and must be renewed, but the roadbed will not require rebuilding if properly constructed and of sufficient width to take care of future as well as present demands of traffic. The selection of the roads to be improved is made to show what could be done under this plan, and can be changed as in your judgment may seem best.

An opinion has been requested by your board from the prosecuting attorney as to the legality of expending any portion of a county bond issue for roads within the limits of an incorporated town or city. If this cannot be done, then approximately $750,000 would be available for additional road improvements other than named in the list given above.

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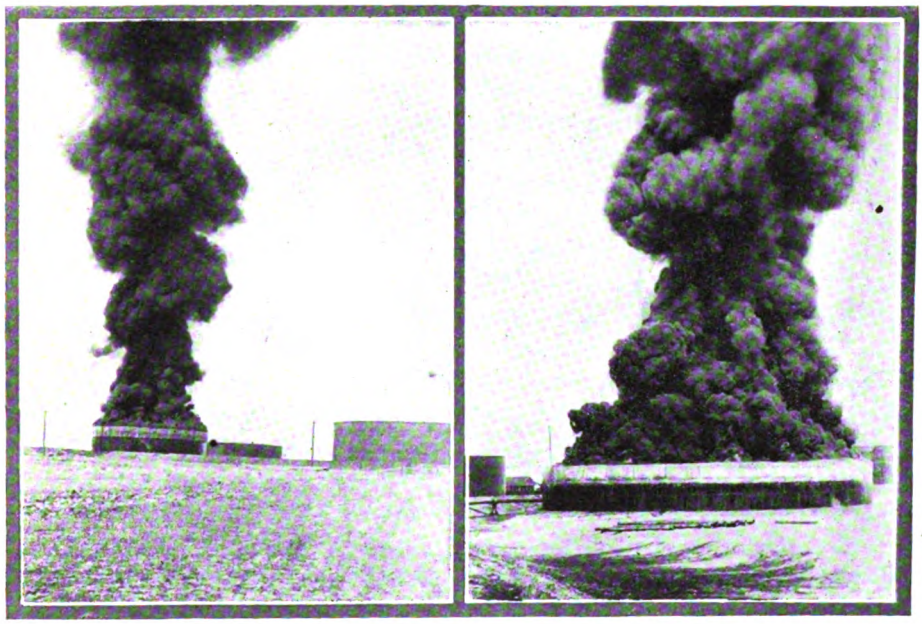
# Unusual Cause of an Oil-Tank Fire

By B. K. STROUD*

OIL in one of the 55,000-bbl. tanks of the Associated Oil Co. at Carneras pumping station caught fire on September 4 at 9.10 a.m., due to a cause unique in the history of conflagrations in the oilfields. Three of the five tanks, namely, No. 1, 2, and 3, were filled with oil, No. 1 tank containing about 48,000 bbl. of 25-gravity oil from the Lost Hills and Belridge fields, while tanks 4 and 5 were empty. These tanks had been erected but a short time and were being connected up on the day of the fire. The tanks are all about 250 ft. apart, and it will be seen from the diagram that tank No. 1 was the centre tank on the south line of the farm, the pump station being at a lower point than any of the tanks. The men were at work laying an 8-in. lateral to tank No. 5 from the main Lost Hills and Belridge 8-in. line, which continued to tank No. 1. The 8-in. gate at *A* was closed, but the 8-in. gate at *B* was open, the main line entering tank No. 1 through an overshot which extended down 24 in. into the tank. At the point *C* the men were working a fire-bend, and the pipe was being heated sufficiently to make the necessary bend when the gas which was lying in the line was ignited, there be-



AFTER FIRE HAD BEEN BURNING FOR EIGHT HOURS. UPPER COURSES WHITE HOT.

AFTER FIRE HAD BEEN BURNING TWO HOURS.

*Universal Oil Co., Wasco, California.



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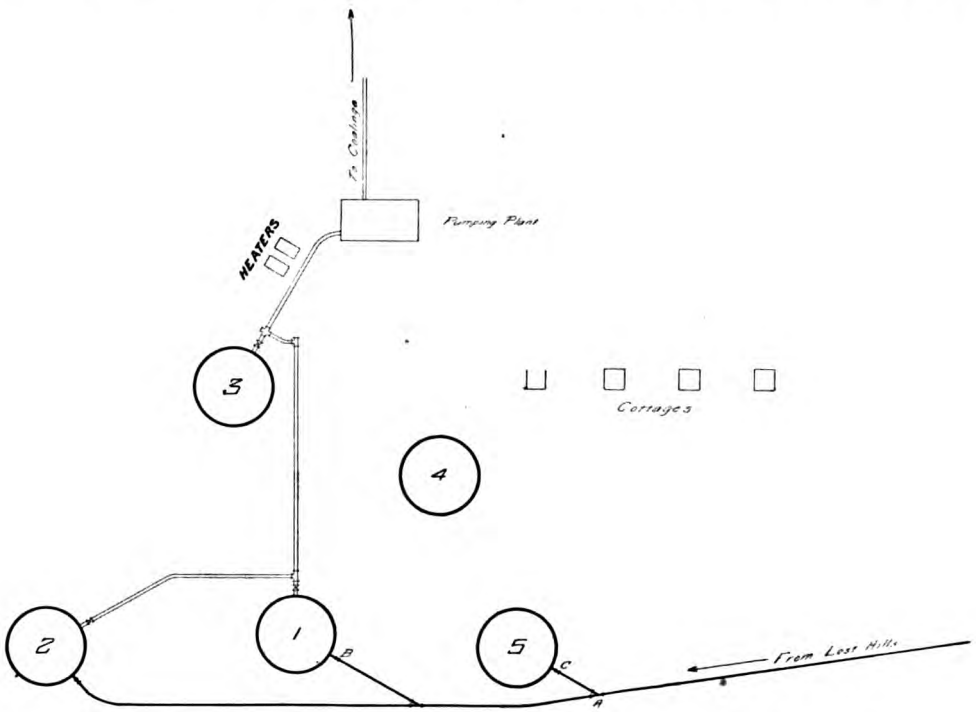
ing enough air in the line to cause this to occur. The fire then traveled back to the Y at *A* and from there through 500 ft. of 8-in. line through the over-shot to tank No. 1.

The instant the fire reached tank No. 1 there was a terrific explosion which lifted the roof from the tank and shook the ground for a radius of half a mile. A few minutes later the whole tank was in flames, and the smoke could be seen for miles, making a huge black pall in the sky. The smoke attracted the attention of every one in the surrounding district, and it was not long before every available automobile and automobile truck was hurrying to the station. W. L. McLaine, formerly superintendent of the Associated Pipe Line Co., and an old experienced pipeline man, was among the first to arrive. He at once had the 18-in. discharge-gate on tank No. 1 opened and the oil flowing down a canyon below the pump station at the rate of about 6000 bbl. per hour. Men with shovels and scraper teams were put to work and a levee thrown up across the canyon. In this way a great deal of oil was saved. The fire burned steadily during the day, the walls of the tank heating and collapsing to the third course at 2:30 p.m. At 6:30 p.m. the water in the bottom of the tank was reached and soon after, enough steam was generated to cause an explosion of steam and hot oil, the flames shooting into the air for 600 ft., throwing the burning oil in all directions.




ARRANGEMENT OF TANKS AND CONNECTIONS, CARNERAS PUMPING STATION.

Early in the day steam had been turned into tanks No. 2 and 3, and the flames did not ignite the oil, although the heat was intense. A large trench had been cut through the dike

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at tank No. 1, and a veritable river of fire poured through this cut and into the canyon opposite the pump station, but this did not entirely relieve the sudden flow of burning oil inside the dike. It rolled over the sides nearest the pump station and tanks 4 and 5, and it was only by the greatest effort that the station and cottages were saved. However, the perseverance of the men and the fact that the wind was blowing in the right direction won out, and the only loss incurred by the Associated company was the loss of a tank and the oil that was burned before the fire was mastered.

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# Atomizing California Fuel Oil

By OSCAR C. GOERIZ*

COMBUSTION being a chemical process, it is well understood that aside from the necessity of perfect atomization, oil cannot be burned efficiently unless the combustion chamber is of proper design and of correct proportions, and sufficient care given to the arrangement and regulation of the air supply. Without regard to what burner-system is adopted, atomizing should require but a small percentage of the total energy contained in the atomized oil, and might give the impression, therefore, that it is a matter of minor consequence. Nevertheless, the development of the various methods in vogue was necessary, because each covers a certain field of greatest usefulness and tries to avoid the shortcomings of the others within the limits of its own application. A number of recently perfected oil-burning contrivances are purposely omitted from this article, as they are used for handling comparatively small quantities of fuel oil for domestic use in heating-furnaces and in kitchen ranges.

The efficiency attained by oil-burners of any type is influenced by the human element to a large degree, and giving due consideration to this fact, it is not surprising that some progressive employers have introduced profit-sharing arrangements with their firemen, thus getting their hearty coöperation and stimulating them to endeavor to obtain the best results with their oil-burners and other parts of the installation. Necessarily, any tendency to cut the bill down to such an extent as to overtax the machinery, as, for example, if locomotive boilers were used, has to be checked by introducing a fair sliding scale, giving an inducement to make an oil saving within reason only. The following discussion of the merits and defects of each mode of atomization, together with the attempts made to overcome their inherent failings, will take into consideration the human element only so far as sudden variations of duty call for a re-adjustment of the burners and the air supply.

**Steam Atomization.**—The various types of steam-atomizing burners, according to efficiency, take about 0.35 to 0.60 lb. of atomizing-steam for every pound of atomized and burnt oil, which represents about 3 to 5% of the steam

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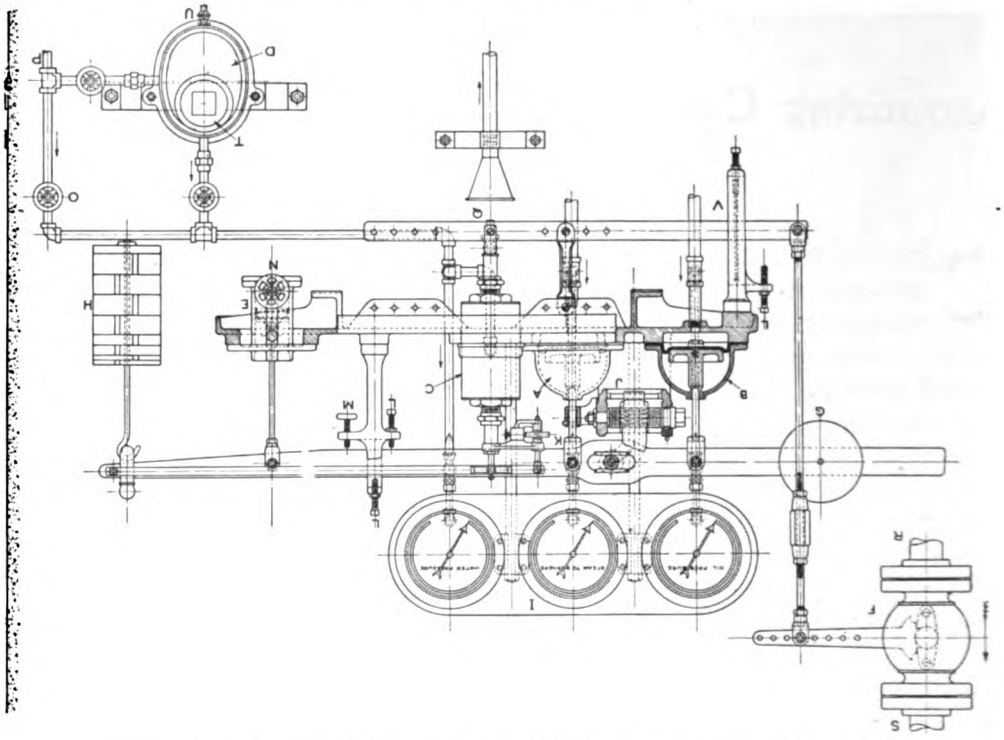
generated. All of these figures refer to the normal duty of burners of this class. There is no doubt that better atomizing results are obtained with steam of full boiler pressure, and that more steam is needed for atomizing if the steam pressure at the burner is kept low. For varying duty, the proportion between the varying quantity of oil and the correspondingly varying volume of atomizing steam, can be regulated with ease. The steam atomizing-burner permits of forcing the fire considerably, a feature particularly desirable at such times when the peak-load is reached in a stationary plant, and also when extra driving force is required for a railroad train or steamer. The atomizing-steam, having a decided tendency to induce draft, offers the advantage of improving the draft if it is permanently weak on account of local conditions, or temporarily so due to wind or weather.

The percentage of atomizing steam may increase to 7 or 10%, and even more, if the fireman, expecting perhaps that the load may increase again at any time, fails to re-adjust the steam for the reduced oil volume. This explains why, under average running conditions, steam is often wasted. Where boiler feed-water is scarce, the loss of steam for atomizing, even if it is only 3% out of the total steam generated, may be a serious drawback or even a positive objection. Such conditions are met on steamers making long trips when they have to buy and store fresh water and thereby sacrifice valuable cargo space. The water question is also serious in such sections of the oil-



ARRANGEMENT OF IMPROVED STEAM TO BURNER REGULATOR. AUTOMATIC FUEL-OIL REGULATING SYSTEM. CHAS. C. MOORE & CO.

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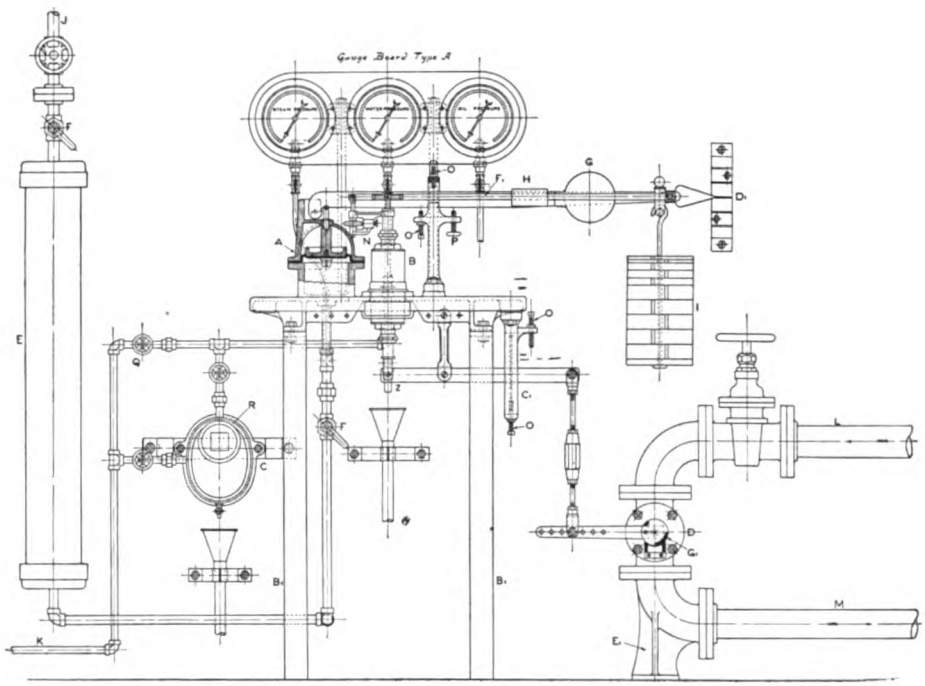
fields where the well-water is poor and where good boiler feed-water must be handled and is consequently expensive.

Various methods have been devised to obtain mechanical control of the amount of oil as well as an automatic re-adjustment of the volume of atomizing steam. Chas. C. Moore & Co. of San Francisco has developed a very complete and efficient system of control, suitable for large power plants, regulating mechanically not only the oil and the atomizing-steam, but also the air supply. It is evident that by reducing the excess of air to a minimum, better boiler efficiency will be attained, thus effecting a saving of fuel oil. Goodwin & Dawson of San Francisco appears to have been the first to introduce a successful modification of the well known pump-governor to take care of the required variations of oil-supply and atomizing-steam, which although very useful for smaller plants, requires that the air supply be regulated by hand.

In the ordinary pump-governor of an oil-pumping set the oil pressure acts on a diaphragm to control the flow of steam to the pump. In the G. & D. modification of this type, the boiler pressure movement acts to adjust the burner oil-control valve so that a suitably altered volume of oil passes through the burner tip. Another diaphragm or combination of diaphragms, according to the type of burner used, operates a controlling valve for the atomizing-steam and establishes a predetermined relation between oil and steam pressure, thus effecting a saving of atomizing steam. It may be well to point out that the oil-pressure in the line is supposed to be kept constant by




ARRANGEMENT OF IMPROVED OIL-PRESSURE REGULATOR. AUTOMATIC FUEL-OIL REGULATING SYSTEM. CHAS. C. MOORE & CO.

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the ordinary pump governor, while for reduced burner capacity, the G. & D. governor throttles the flow from the pipe-line to the burner tip. In view of the advantages of the steam-atomizing burners, one would anticipate that considerable attention would be given to multiple-effect evaporation for obtaining distilled-water direct from sea-water. About 3 lb. of distilled water can be obtained in a quadruple-effect evaporation for every pound of low-pressure heating steam introduced into the steam belt of the first effect. Figuring on 13 lb. of water evaporated per pound of oil used in the main boilers, 1 lb. will produce 39 lb., or 1 bbl. of oil about 13,000 lb. of distilled water. This is about 1550 gal., which will represent a value of about 77c. if 1000 gal. cost 50c. delivered in the water tanks, and which must be carried hundreds of miles in the steamer. To arrive at the cost of this distilled water, one has merely to consider the depreciation and interest on the investment for the multiple-effect evaporator, maintenance, and whatever attendance is needed for operation, because if such a system is run intelligently, one would not pass full-pressure steam through a reducing valve, but would utilize all available energy between the full boiler pressure and the 5 or 10-lb. gauge pressure generally used for the jacket of the first effect. It is common practice, in fact, to let the steam do useful work, such as supplying heating steam for running auxiliaries, before it is thrown into a multiple-effect evaporator. Sometimes it is taken from the low-pressure receiver of the main engine, or, in the most modern installations, it is tapped from a suitable point between certain stages of a steam turbine. Such use of steam is more economical than condensing it in a surface condenser and thereby throwing all the latent heat into the sea, as is the case when the hot circulating water from the condenser is being discharged overboard. As indicated above, the power must be developed anyway, and if the latent heat of the steam is utilized, it would not be fair to charge the product of the heat-utilization with the fuel bill, because the latent heat would be wasted in a stationary power-installation. Therefore, while the oil must be utilized for the power, the other items concerned in the multiple-effect evaporation must be considered in order to arrive at the cost of the 1550 gal. of pure water generated for each barrel of fuel oil used for supplying steam to the evaporater. The latter can be connected with the existing condensing outfit of a steamer in order to economize in cost and in space. It is interesting to note that for every 1000 indicated horse-power of the main engine, a coal-burning steamer uses about 5 tons of fresh water per 24 hours, on an average, for all general purposes on board. This supply must be furnished either from fresh-water tanks, evaporators, or from both combined. When the change is made from coal to oil-burning, the steam atomizing-burners, on the same basis, add a fresh-water consumption of about 8 tons. The total will therefore rise to 13 tons of water, or say to about 2½ times the quantity shown by the previous figure. It is not astonishing that the single or double effects that are fed with steam through a reducing valve, or which are run non-condensing, and which, therefore, must be charged with the oil bill, are not very popular with ship owners, because they are not efficient enough to produce water at a cost as low as when it is bought and carried in tanks. Conditions very similar to those on shipboard

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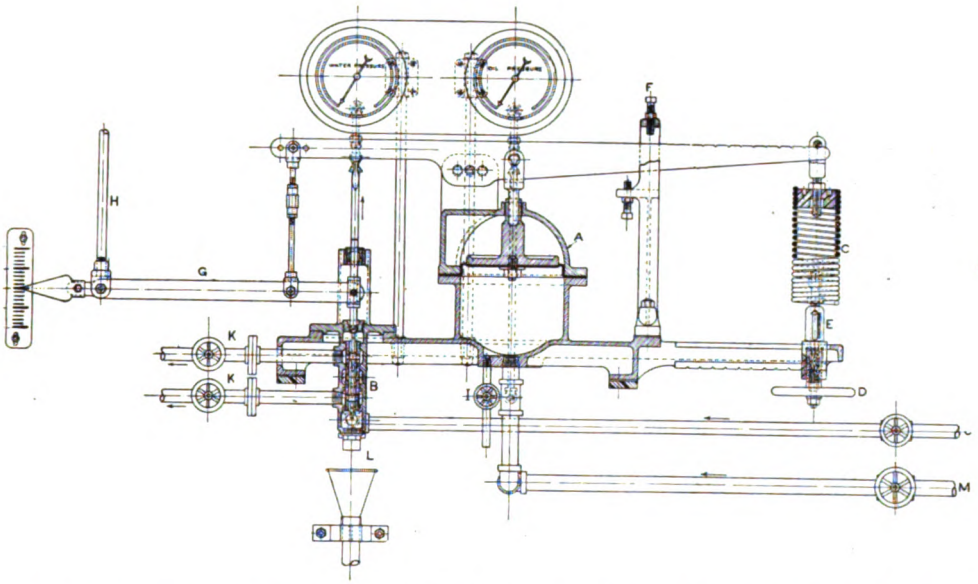
are frequently found in the oilfields, where every drop of water should be saved, because well-water is quite often contaminated with alkali, the effect of which cannot be remedied by any commercial system of chemical treatment.

The rather lengthy discussion of the multiple-effect evaporators appears justified in this connection, as engineers are inclined to think that they are complicated, while a visit to a salt or sugar works will convince anybody of the simplicity of their operation. While triple-effects are used in salt works for the concentrated brine, the quadruple and even quintuple-effects are available for evaporation from sea-water, provided one refills after a salinity about three times as large as the initial has been reached.




ARRANGEMENT OF IMPROVED DAMPER CONTROLLER. AUTOMATIC FUEL-OIL REGULATING SYSTEM. CHAS. C. MOORE & CO.

**Atomizing by Compressed Air.**—Practically the same burners which have been developed for atomizing by steam are being used in connection with compressed air at ordinarily 20 to 25-lb. gauge pressure, but in some cases as high as 80-lb. pressure. The weight of free air needed for atomizing the fuel oil is necessarily somewhat larger than that of steam with higher pressure and larger energy per pound, and figures of 0.40 to 0.80 lb. of free air per pound of oil are on record for this method of atomization, or say a corresponding volume of 5 to 10 cu. ft. of free air for every pound of fuel oil. Where duplicate compressors are installed, it is safe to use the smaller figures, while with a single compressor the maximum displacement will permit of running the machine eventually at a reduced speed, which will prolong its life and particularly that of its valves and springs. Compared with steam, compressed air offers the main advantage that it assists combustion, and that no moisture is introduced into the combustion chamber. This makes the air system very desirable for kilns and roasting furnaces. What has been said

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as to the ease of regulation for steam applies also to compressed air, and the latter permits of forcing the fires also to some degree. There is also some slight improvement of draft conditions due to the discharge of the compressed air through the burner tip. The main consideration for the adoption of atomizing by compressed air, aside from its use in kilns, etc., is the saving of water wasted by the steam-burner.

The human element is of the same influence and importance as with steam-atomizing burners. The advantage of not wasting steam through the stack is gained at the expense of the first cost, operation, and upkeep of an air-compressor. The attendance for the latter will probably be more trouble than the operation of a multiple-effect evaporator run in conjunction with an existing condensing outfit. The fact that there are practically no stationary boiler plants which use compressors for atomizing purposes, appears to prove further that this system is more wasteful than the steam-atomizing burner, as is shown by a comparison of the requirements of steam and of air according to the figures given in this article. The only remedy which can be suggested in regard to a reduction of the running expense, maintenance, and repairs for a piston-type compressor is the adoption of the modern rotary, multi-stage air-compressor. Similar to the increasing use of multi-stage boiler-feed pumps, operated either by steam turbine or electric motor on board of steamers, it is only a question of time and of further development before the direct-connected high-speed rotary machine will prove its usefulness and ability to furnish compressed air for oil atomization.

**Mechanical Atomization.**—This is the latest system in use on the Pacific coast. As early as 1908 I installed Koerting burners for use in conjunction with heavy California fuel oil. For the purely mechanical system, it is only necessary to put oil under pressure, and to heat it sufficiently to make the oil more liquid. A certain degree of temperature is desirable to obtain a corresponding physical effect by evaporation of the lighter parts of the oil when discharging from the tip. Aside from the mechanical atomizing effect, there is a definite relation between pressure and temperature for any quality of oil. With higher pressure, it is possible to use a lower temperature. The apprehension felt by many engineers that the asphalt base oil would carbonize in the burner, particularly at the tip, is groundless for a temperature not higher than 240°F. if the pressure exceeds 40-lb. gauge. To pump the oil and heat it sufficiently for use in mechanical burners requires only about ¾ to 1% of the steam which is generated by the atomized oil. All the steam supplied to pumps and heaters can be condensed and is not lost for subsequent use in the boiler. There are three ways to regulate the oil capacity of the mechanical burner for varying duty: (1) The oil pressure may be modified between limits of 40-lb. gauge and 100 or even 150-lb. gauge pressure, the lower limit being given by the necessity of avoiding carbonization of the burner, and the upper limit by the allowable safe working pressure of the pump-set. These variations of oil pressure, and the corresponding change of velocity of the oil issuing from the top, are obtained for all the burners at the same time by the adjustment of the pump governor. The latter, situated centrally, should be of such construction as to permit of an easy and quick adjustment. (2) The number of burners per boiler, or even

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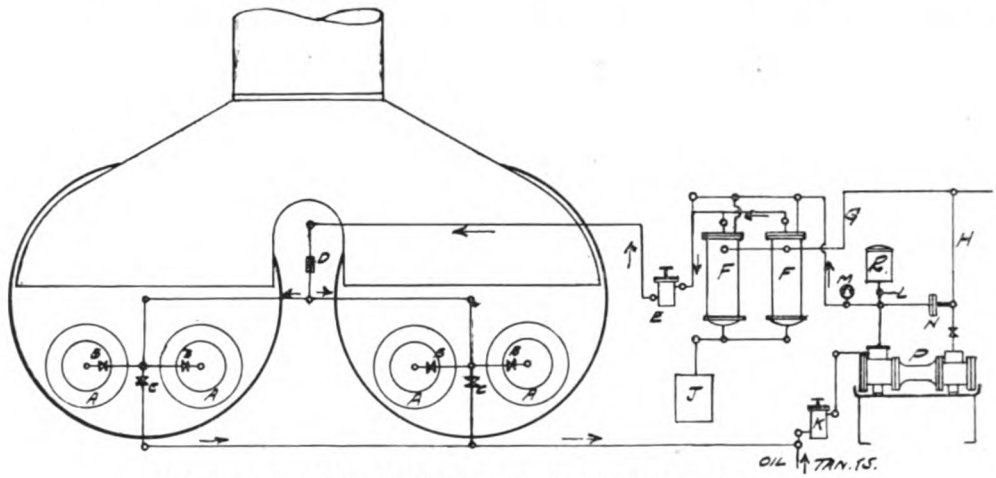
the number of boilers, can be reduced by cutting some of them off, temporarily. The unequal expansion and contraction which eventually causes leaks should be borne in mind before making it a regular practice to regulate in this way. (3) Keeping the given number of burners per boiler in commission, also keeping the oil pressure normal. The normal pressure should be determined so that the pumping-set may permit some leeway of pressure when it is desired to force the fires. The variation of quantity of oil discharged, caused by opening or closing the discharge ports right at the tip while keeping the oil pressure at its full value, should give the best results. With a mechanical burner depending upon pressure and the corresponding velocity for the atomization of the oil, one should avail one's self of the highest permissible pressure and not reduce the latter if possible.




MECHANICAL OIL-ATOMIZING SYSTEM. MOORE & SCOTT IRON WORKS.

The principal advantage is the fact that no water is lost by this system. The oil can be atomized and burned as effectively as with steam burners, if the condition of the combustion chamber, heating surface of boiler, and drafts are right. In comparison with atomization by compressed air, it is easier to effect a saving of oil by the mechanical system. Burners of the mechanical class are noiseless, unless there is a large percentage of water contained in the crude fuel oil. This fact makes the mechanical burner very desirable for steam whalers, as it was found that the high-pitched noise produced by steam-atomizing burners was transmitted through the water and scared the whales away. The absence of noise is a decided advantage when applied to steamers in the passenger-carrying class also. It would appear that a larger excess of air would be required for the mechanical burner than for the steam-atomizing burner. Under these conditions such savings as are effected at the atomizing end, may be entirely lost in another way by a reduction of boiler efficiency due to an increase of stack temperature and a reduction of $CO_2$ in the gases escaping through the stack. The net evaporation is therefore approximately the same as that of the steam-atomizing system. The human element comes in particularly as to regulation of the air supply, which

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must be cut down to a sufficient extent to cause the fire to begin to smoke slightly.

The original Koerting burner, as well as others of the same type, both local and foreign, making use of centrifugal force for atomizing, give a flame of conical form. This is quite suitable for Scotch marine and other internally fired boilers, but it necessitates remodeling of Babcock & Wilson, Heine, and other water-tube boilers. The flame is apt to strike either or both heating surface and the furnace bottom, causing smoke and carbonization, unless the bottom is 5 or 6 ft. below the heating surface. This makes additional expense, and in some cases, as in steam-schooners, it would mean raising the boilers in order to gain sufficient height for the combustion chamber. The steam or compressed-air system use about 125 to 150°F. oil-temperature, and sometimes even far less. Therefore whenever the mechanical system is advocated there is danger of hot oil of say 240°F. eventually leaking from the heater.

If there is a lack of draft, the mechanical burner is liable to smoke, and the same defect applies to any attempt to force the mechanical burner much over its rated capacity. To reduce the excess air to the allowed minimum without difficulty, various types of air registers have been developed which permit quick changes of the air openings. In view of the disadvantage of a conical flame striking, in cases where the combustion chamber is low, a mechanical burner for a flat flame has been developed by the Schutte & Koerting Co., originally for auxiliary-oil spraying in the boilers for the United States battleships, but later on with good success in connection with Heine water-tube boilers. For such burners, the same setting can be retained which is in use for steam-atomizing burners using a fan-shaped flame, and the air supply can be controlled by the ash-pit door without a complicated air-register. To reduce the danger of leaks, heaters must be used which are tested under high pressure and which have only a small space for the hot oil, so that the oil flame would burn out quickly without doing much damage if there ever should be an accident. If there is a lack of draft, according to conditions resulting from wind or weather, the mechanical burner is certainly 'up against it,' and smoking cannot be prevented in that case unless auxiliary means, such as a rotary blower direct-connected to a motor or a steam turbine is provided for creating the necessary draft.

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# Constructing Oakland Harbor Quay Wall

By CHARLES T. HUTCHINSON

HARBOR improvements undertaken by the city of Oakland, California, embrace a comprehensive plan for betterments that will make Oakland a strong competitor for a share of the traffic that will enter San Francisco bay coincident with the opening of the Panama canal. The work now under way includes the construction of four sections of concrete quay-wall on the south side of San Antonio estuary, 2005 lineal feet in all, extending from Howard's wharf, below the foot of Market street on the west to a point above the foot of Clay street on the east, and it is with this portion of the work that this article will deal.

The site selected for the quay-wall is 300 ft. inland from the United States pierhead line. The excavation consists of a continuous, open trench about 44 ft. deep with an average width of about 30 ft. During the course of excavation, sheet piling is used, as the ground, although exceptionally hard, will not stand without support. Sewer-pipe sub-drains about 6 in. inside diameter, are laid horizontally along the bottom of the trench, and seepage water is pumped out in order to assure a comparatively dry footing for the concrete wall. The wall is made of reinforced concrete 22 ft. wide on the bottom, 18 in. wide at the top, and 47 ft. 6 in. high over all, as shown in Fig. 1. Hydraulic portland cement is used, and was supplied by the Standard Portland Cement Co. The test required by the city engineers was as follows:

**Fineness.**—Cement shall leave by weight a residue of not more than 8% on the No. 100 and not more than 25% on the No. 200 standard sieve.

**Tensile Strength.** — Cement, when made into briquettes and tested neat, shall have a tensile strength of not less than 500 lb. to the sectional square inch after an exposure of 1 day in air and an immersion of 6 days in water.

**Constancy of Volume.**—Pats of cement made on glass and brought to thin edges shall show no signs of distortion, checking, cracking, or disintegration under the following conditions:

Pat No. 1 in moist air for 24 hours and 6 days in water.

Pat No. 2 in moist air for 24 hours and 3 hours in steam at about atmospheric pressure.

**Time of Setting.**—The cement after wetting shall take not less than 30 minutes to set, so that it will bear without indentation a round wire one-twelfth inch diameter placed endwise and loaded to a total weight of one-fourth pound.

Cement passing all of the above tests satisfactorily, except pat No. 2 shall be held until pat No. 1 is 28 days old, and if at that time pat No. 1 shows no signs of distortion, checking, cracking, or disintegration, the cement will be accepted.



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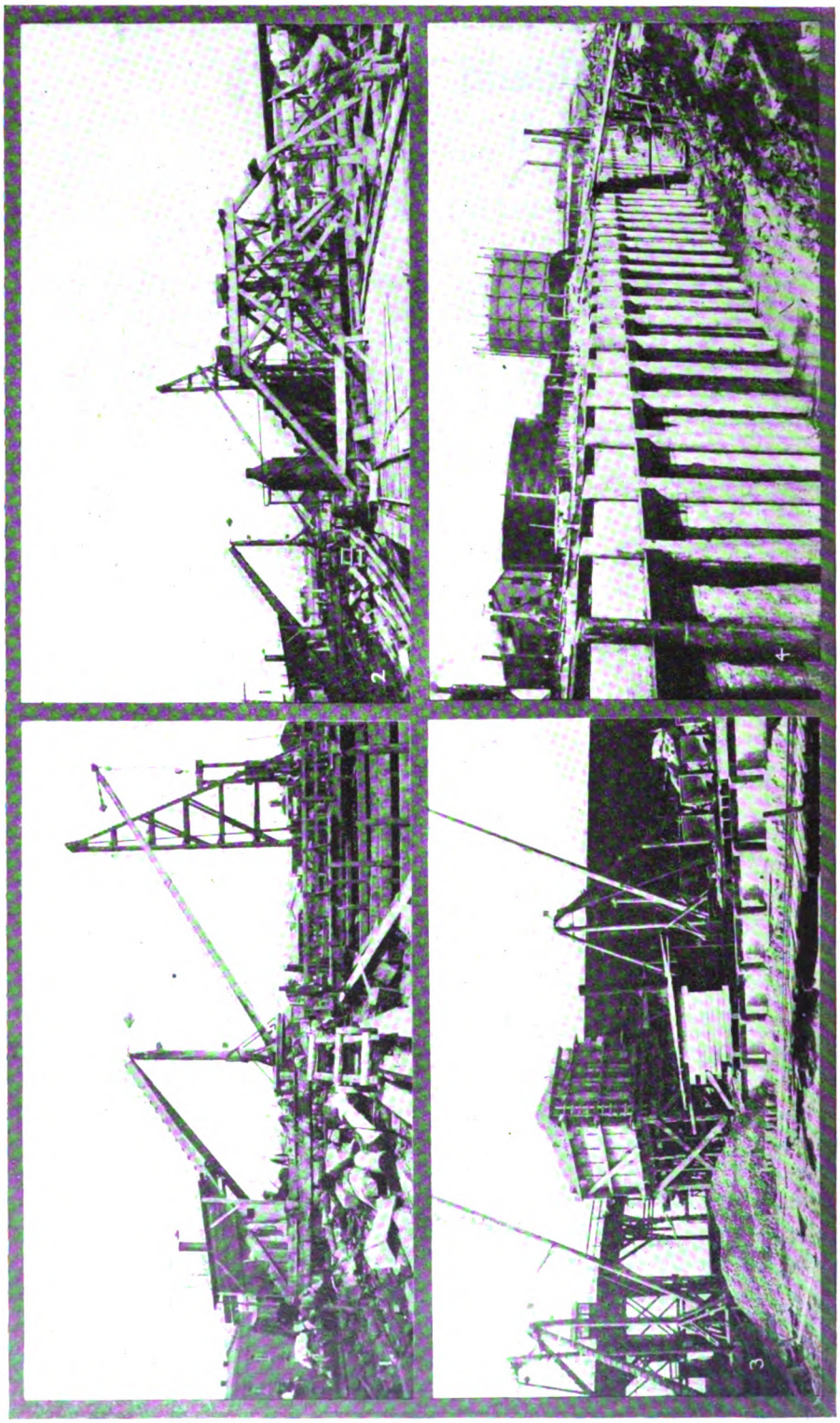

1. DRIVING SHEET-PILING.
2. VIEW OF PORTABLE DREDGE PUMP AT SURFACE.
3. CONCRETE-MIXING PLANT.
4. SECTION OF COMPLETED WALL, SHOWING FENDER PILES.

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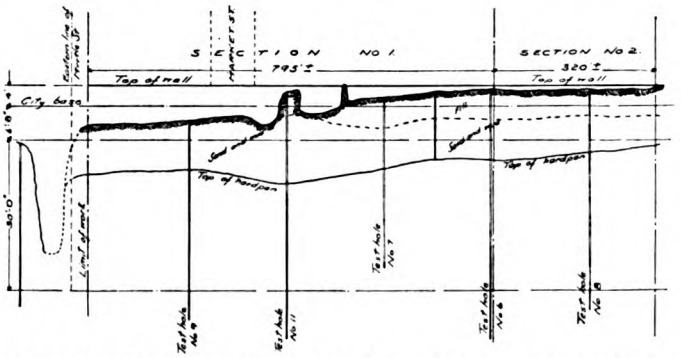
Specifications also require that any cement failing to develop sufficient tensile strength in the first test shall be re-tested as originally prescribed and that, in addition, a lot of six briquettes shall be allowed to set 1 day

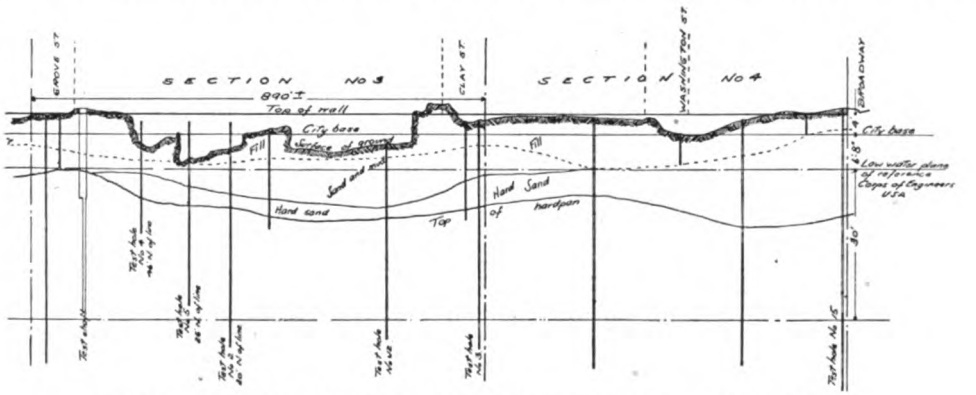
Clean sharp silicious sand is used, containing not to exceed 3% by volume of silt. A screen analysis shows by volume 60% through 20 mesh, 85% through 50 mesh, and 15% through 80 mesh, while that used for rubble con-




SECTIONS 1 ANL 2, SHOWING FORMATIONS ENCOUNTERED IN DIGGING TRENCH.

in moist air and 27 days in water. Cement passing the re-test satisfactorily will be accepted, otherwise it may be held until the other lot is 28 days old, when it will be accepted

centrate shows not more than 6% through 100 mesh. Proportions of cement and sand for briquettes are 1:3. Broken stone used will pass a 1½-in. ring maximum and all below ¼-in.




SECTIONS 3 AND 4, SHOWING FORMATIONS ENCOUNTERED IN DIGGING TRENCH.

if it develops a strength of 650 lb. per square inch. In making all the briquettes for tests under these specifications the pats are compacted in molds by the use of the fingers only, and only sufficient water is used to allow of properly compacting the paste in this manner.

ring is rejected. Requirements for gravel call for sizing so that not to exceed 6% of the particles passing a ¼-in. screen shall pass 100 mesh, while the maximum shall not pass a 1½-in. ring. Rubble-rock used is not less than 1 ft. in least dimensions nor so large as to occupy more than one-half

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the horizontal distance across the well at the point where placed, nor present an area of face of more than 1 sq. ft.

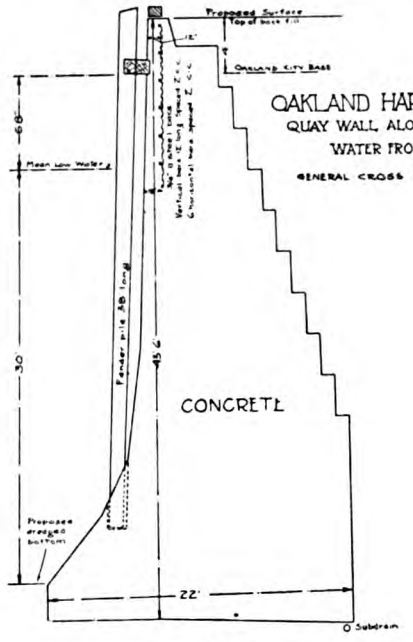


FIG. 1.

of 12 in., and rubble-concrete for the balance of the wall. Proportions used for facing-concrete are 1 bag or 94 lb. of cement to 2½ cu. ft. of sand and 5 cu. ft. of broken stone. Rubble-concrete mix consists of 1 bag or 94 lb. of cement to 9 cu. ft. of aggregate consisting of 1 part by volume of sand and 2 parts by volume of broken stone. When gravel aggregate is used, the proportions are 1 part of sand and particles ¼ in. fine to 2 parts of coarser material. Batch-mixers are used in order to insure accurate proportioning of material. Remixing with water after concrete has partly set is forbidden. The wall is being built in 16-ft. sections in which the concreting is carried on continuously until completed, and forms are not removed until three days after completion.

Open-hearth or high-carbon steel bolts and structural steel reinforcing bars are used. The structural steel has

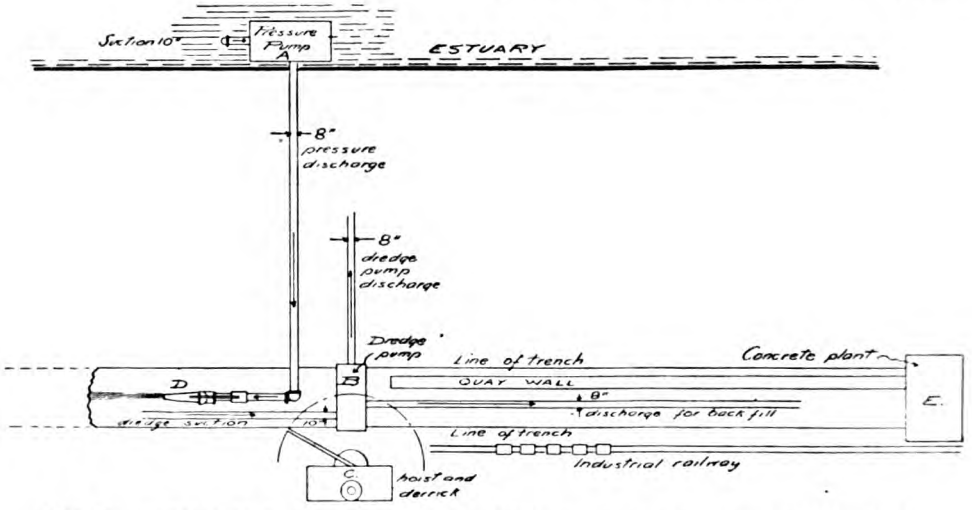


FIG. 2. SCHEMATIC PLAN OF SURFACE PLANT, OAKLAND QUAY WALL CONSTRUCTION.

facing the forms at a distance of 18 in. from the surface of the wall.

Two classes of concrete are used, facing concrete for the front face and over the top of the wall for a thickness

an ultimate tensile strength of 60,000 lb., shows a silky fracture, and may be bent cold 180° without fracture. The high-carbon steel has an ultimate tensile strength of 88,000 lb., shows a

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silky or granular fracture, and may be bent cold without fracture 180° around a mandrel four times the diameter of the specimen. Galvanized and painted expansion bolts and wedges are used for wales. Fifteen cast iron mooring posts are bolted on a concrete base at the top of the wall in suitable positions.

Fender-system includes a series of

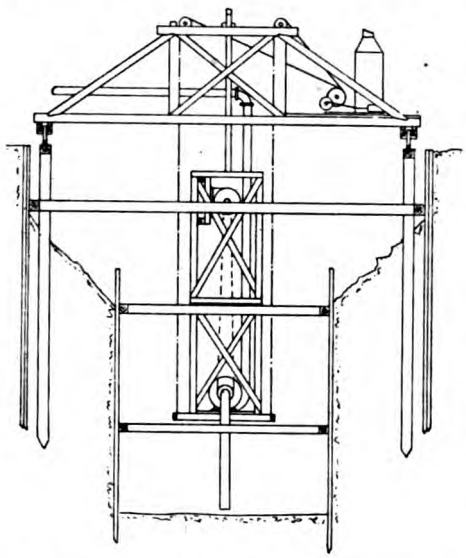

FIG. 3. PORTABLE DREDGE PUMPING OUTFIT.

peeled piles 15 in. diameter at the butt and 10 in. diameter at the small end, and approximately 38 ft. in length, set 8 ft. centres, and painted with two coats of white lead and linseed oil. The other timber in the fender-system, including chocks and wales, is Douglas fir. All timber work is creosoted with pure dead oil of coal-tar that introduces 12 lb. of oil into the timber for each cubic foot of material treated. The excavated space landward from the wall is to be back-filled in horizontal layers 3 ft. thick with selected hardpan and sand from the trench excavation. Hansborough Bros. were the original contractors for the work, and after partly completing some 308 ft. of the wall, were forced to acknowledge failure to accomplish the work on account of their inability to overcome the many physical difficulties encountered.

The ground a few feet below the surface is a hard-pan, so closely cemented as to be almost a sandstone. Grab-buckets, drag-line excavators, or apparatus of this type could not be employed. A network of sewers and water-pipes cross the line of the quay-wall to the estuary. These, of course, cannot be disturbed, and offer a constant danger from flooding in case any of them should be accidentally broken. It is evident that new methods had to be devised to meet all the conditions imposed by the city specifications and at the same time enable the successful builder, when the work was re-advertised, to pull out not only without financial loss, but with a reasonable profit. After giving the conditions careful study, a surface equipment was laid out and put into use that has more than justified the expectations of its designer. A schematic plan of the entire outfit is shown in Fig. 2. *A* is a high-pressure pumping plant including a 4-stage Krogh centrifugal pump, direct connected to a 300-hp., General Electric, 3-phase, 60-cycle, 220-volt induction motor. The pump is erected on a barge in the estuary and draws salt water through a 10-in. suction pipe and delivers it through an 8-in. discharge about 1000 ft. long to a 1¾-in. nozzle Hendy hydraulic giant (*D*) at the rate of 1500 gal. per minute at 300 lb. pressure at the nozzle. The nozzle is directed against the face of the trench and washes out an average of 10 lineal feet per working day, 1 lineal foot being the equivalent of about 50 cu. yd. The ground is so hard and closely compacted that the 'undermine

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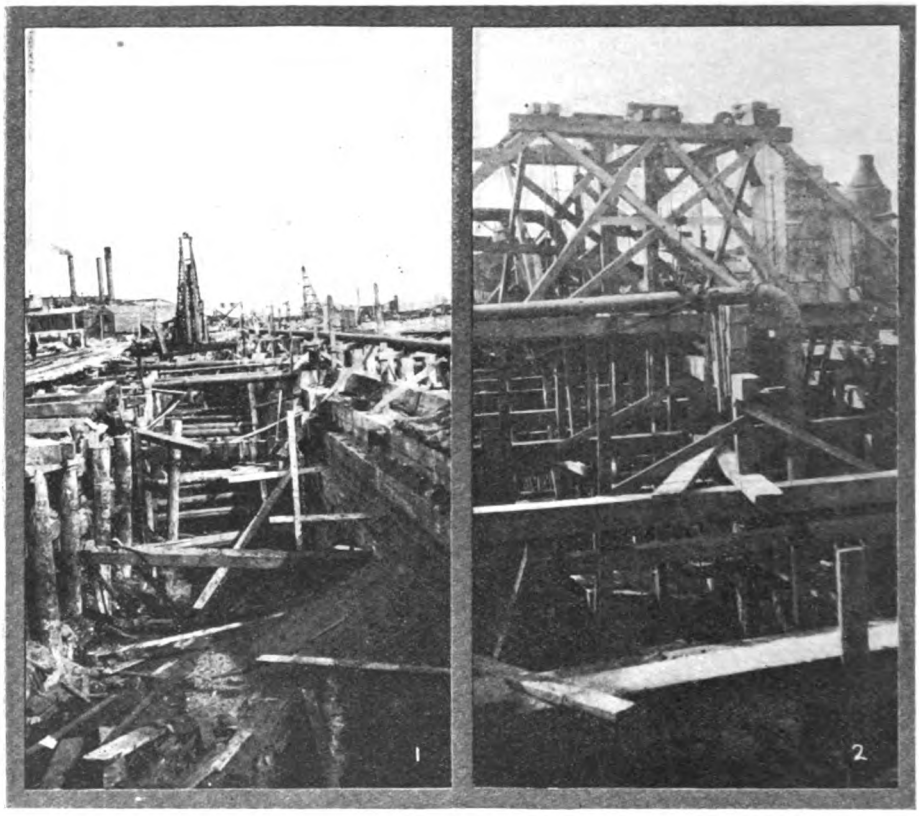
and cave' method cannot be used. The face of the trench is literally worn away by the impact of the water. The hydraulicking process is not continuous, as frequent stops are necessary for sheet piling, timbering, and shifting pipe-lines, pumps, etc., to keep up with the progress of the work. Not more than two hours per day of hydraulicking is averaged, the use of electricity for power doing away with all stand-by losses.

The pumping plant (*B*) for removing the material washed away by the giant and the hydraulic water was specially designed with a view to ready portability in case of floods. General arrangement of this plant is shown in Fig. 3. An 8-in. dredge pump is driven by belt from a 75-hp. Westinghouse, 3-phase, 220-volt induction motor. The pumping plant is set in a vertical frame and suspended from wooden trusses mounted on wheels resting on tracks bolted to the sheet-piling at either side of the trench. A stiff-leg derrick (*C*), equipped with a double-drum donkey-hoist, is used for raising or lowering the dredge pump, jacking it ahead as the work progresses, operating a drop-hammer for driving sheet-piling, handling and placing fender-piles in position, etc. Arrangement of discharge piping for the dredge pump permits



1. PARTLY COMPLETED WALL WITH FORMS REMOVED.
2. PORTABLE DREDGE PUMP IN POSITION.

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the discharge of such excavated material as is required for back-filling at any desired point, and the balance between the quay-wall and water-line, where desired. It will be necessary to dredge out all of this latter material after completion of the work, as the quay-wall is nearly 1000 ft. from the present estuary water-line.

The concrete-mixing plant (*E*) is erected at Howard's wharf, to which all crushed stone, sand, gravel, and cement is brought by water. The concrete material is fed to separate compartments in a bunker by automatic grab-buckets and then discharged by gravity to a specially constructed mixing platform which delivers a correctly proportioned mix to the mixer. Mixed concrete is transported from the mixing plant to the wall-forms by a Koppel portable industrial railway with double side-dump cars. F. C. Turner is city engineer, Healy-Tibbetts Construction Co. is the contractor for the entire work. The surface plant was designed by Leland S. Rosener, consulting engineer for the contractor, to whom I am indebted for notes for the preparation of this article.

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# Estimating the Capacity of Horizontal Cylinders

By A. H. BABCOCK*

TO determine the content of a cylindrical gasoline tank (axis horizontal), by passing a measuring rod (yardstick) through its bung, its length and diameter being known:

Required, the equation to the curve that expresses gallons in terms of inches depth of the liquid.

Volume = area of wetted end section by length of cylinder.

For convenience locate the origin as shown, and consider the yardstick placed on the $x$ axis (see figure for the argument, and the table for an example). Of course, the foregoing assumes plane heads. If the heads are dished or crowned, the volume to be subtracted or added must be calculated separately and the corrections applied to the points as determined, unless the deviation from plane heads is so small as to be of no practical account. Much time and labor can be saved in calculating the points for the curve by remembering that since the value of the constant is equal to half the area of the whole circle, the sum of the other two terms must be negative for all values of $x$ between $x = O$ and $x = r$, and positive for all other values of $x$; also, that the curve is symmetrical about its centre: hence, calculate the sum of the first two terms for sufficient values of $x$ to give points for a smooth curve up to the value $x = r$. They will all have the minus sign. Then these values written in the inverse order, with the plus sign, will give the sum of the first two terms for the symmetrical points of the curve

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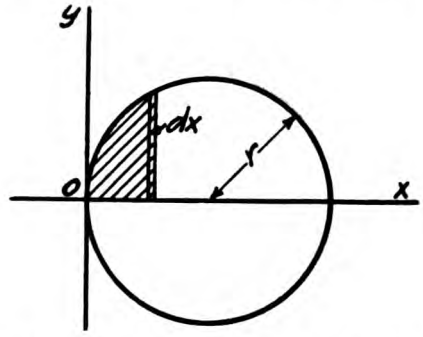
between $x = r$ and $x = 2r$; or a more simple method is to calculate the points up to $x = r$ as above, and then, by differences, merely reflect the curve.

Where rigid precision is not demanded, it will be easier to measure into the tank successive volumes of liquid—say five gallons—and by a yardstick measure the depth after every addition; a curve plotted from these points usually will be nearly enough accurate for all practical purposes. In any event, this is a very simple check to apply to the curve. In the case of an oil drum with crowned head for which a curve recently was calculated,




The equation to the circle with origin at the circumference is

$$x^2+y^2=2rx$$

from which $y=\sqrt{2rx-x^2}$ and the area above the axis (shaded) $=\int\sqrt{2rx-x^2}\,.dx$ which, integrated, gives $\frac{x-r}{2}\sqrt{2rx-x^2}+\frac{r^2}{2}.\sin^{-1}\left(\frac{x-r}{r}\right)+C$

and the whole area both above and below the x-axis then is $(x-r)\sqrt{2rx-x^2}+r^2\sin^{-1}\left(\frac{x-r}{r}\right)+C$

The value of the constant of integration is determined as follows;

In the limit, when $x=2r$, $A=\pi r^2$

$\therefore$ by substitution

$$\pi r^2=(2r-r)\sqrt{4r^2-4r^2}+r^2\sin^{-1}\left(\frac{2r-r}{r}\right)+C$$
$$=r^2.\sin^{-1}(1)+C$$
$$=\frac{\pi r^2}{2}+C$$

and $$C=\frac{\pi r^2}{2}$$

Hence the area of the wetted end section is,

$$(x-r)\sqrt{2rx-x^2}+r^2.\sin^{-1}\left(\frac{x-r}{r}\right)+\frac{\pi r^2}{2}$$

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the head correction was applied. On first filling, the gasoline was carefully measured into the tank as a check on the calculations, and the points plotted fell as closely on the curve as a yardstick graduated in eighths of inches could be read.

**Example.**—A tank of inside dimensions 28½ in. diam. by 37½ in. long, with plane heads.

Constants: $r = 14.25$. $L = 37.5$.

$\frac{\pi r^2}{2} = 3.19$.

Second term = angle in degrees $\times$ $\frac{\pi r^2}{180} = 3.54$.

Volume (gal.) = area $\times$ $\frac{L}{231}$ = 0.1623.

| x | x-r | 2rx-x² | 1st term | $\sin^{-1}\frac{x\text{-}r}{r}$ | 2d term | term 1+ term 2 | area | vol. |
|---|---|---|---|---|---|---|---|---|
| 1.0 | -13.25 | 27.5 | - 69.5 | -68.43° | -242.0 | -311.5 | 7.5 | 1.22 |
| 3.0 | -11.25 | 76.5 | - 98.4 | -52.20 | -185.0 | -283.4 | 35.6 | 5.78 |
| 5.0 | - 9.25 | 117.5 | -100.2 | -40.47 | -143.0 | -243.2 | 75.8 | 12.29 |
| 8.0 | - 6.25 | 164.0 | - 80.0 | -26.05 | - 92.3 | -172.3 | 146.7 | 23.80 |
| 11.0 | - 3.25 | 192.5 | - 45.1 | -13.18 | - 46.6 | - 91.7 | 227.3 | 36.9 |
| 14.0 | - 0.25 | 203.0 | - 3.6 | - 1.01 | - 3.6 | - 7.2 | 311.8 | 50.6 |
| 14.5 | ..... | .... | ..... | ..... | ..... | 7.2 | 326.2 | 53.0 |
| 17.5 | ..... | .... | ..... | ..... | ..... | 91.7 | 410.7 | 66.7 |
| 20.5 | ..... | .... | ..... | ..... | ..... | 172.3 | 491.3 | 79.8 |
| 23.5 | ..... | .... | ..... | ..... | ..... | 243.2 | 562.2 | 91.3 |
| 25.5 | ..... | .... | ..... | ..... | ..... | 283.4 | 602.4 | 97.8 |
| 27.5 | ..... | .... | ..... | ..... | ..... | 311.5 | 630.5 | 102.3 |
| 28.5 | ..... | .... | ..... | ..... | ..... | .... | 638.0 | 103.5 |

It is a simple matter to measure the quantity of gasoline in a rectangular tank with a yardstick, but when the tank is cylindrical and lying horizontally, it is a genuine problem. Many men who take care of their own cars do not care to go to the expense of installing one of the more elaborate outfits with automatic recording gauges and other expensive accessories. Nearly all the city ordinances governing the storage of gasoline require that the storage tank be submerged 6 ft. below the surface of the ground, and it is a wise precaution to take in any locality, even if the law does not require it. Automobilists who store their own gasoline will appreciate the advantage of applying Mr. Babcock's formula and thereby being able to ascertain instantly the amount of stock they have on hand.—EDITOR.

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# The Engineering Digest

## Influence of Moisture on the Expansion and Contraction of Concrete*

By LOGAN WALLER PAGE

NUMEROUS cracks appear in many concrete structures soon after their completion, and the reason in most cases is not the failure of the concrete to resist the external loads imposed, but is due to the inherent contractive qualities of the concrete mass. The shrinkage due to a fall in temperature has been very carefully measured by a number of investigators, who quite generally agree that 0.0000055 in. per inch of length per degree Fahrenheit is the correct value of the contraction. The temperature changes are due not only to the variation of external temperature, but also to the chemical activity of the cement during the hardening process.

The fall in temperature of a mass of concrete caused by atmospheric change has long been recognized as being of sufficient magnitude to cause cracking. It has also been demonstrated, notably by the Boonton dam experiments, that very high temperature may be developed in large masses of concrete during the hardening process. In time, as the heat is dissipated by conduction and radiation, the temperature is bound to fall, with the production of enough tensile stress to cause cracking. Another source of contraction, that due to drying out the water from the concrete mass, is likewise known to exist, but the information is qualitative rather than quantitative.

The tests were conducted on columns 8 in. square and 5 ft. long, and the concrete was mixed in the proportions of 1:2:4 and 1:3:6. The materials used were portland cement passing the specifications of the American Society for Testing Materials, well graded, clean river-sand, and crushed gneiss. Two consistencies were used—very wet and very dry. The very wet concrete was simply puddled into place, while the very dry was tamped into the mold with difficulty.

One-half-inch bars, square in cross-section, were molded in the specimens 50 in. apart. Upon removing the wooden forms these bars projected 1½ in. on each side of the specimens. Steel plugs with rounded conical points were attached to the square bars, and measurements were taken between the points by means of a micrometer fitted to a specially designed frame. With this apparatus, readings could be taken accurately to a few ten-thousandths of an inch.

As soon as the concrete had hardened sufficiently, the molds were removed and the initial readings taken. The temperature of the specimens and that of the air were noted at each reading of the micrometer, and all readings were corrected to constant temperature. In this way the influence of temperature changes, either in the atmosphere or in the concrete, were eliminated, and the deformations obtained therefore represent the change in length of the concrete due to the effect of moisture alone.

The results obtained agreed with those of previous investigators in showing that concrete expands when it is allowed to harden under water and contracts when allowed to harden in air. Those specimens which hardened in air showed contraction almost from the beginning of the test. A very slight expansion, too small to be plotted, took place during the first day or two. The tests indicate that the 1:2:4 mixture contracts

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more than the 1:3:6 mixture; likewise that the greater portion of the contraction takes place within the first three months and fully 50% of it within the first month.

The amount of the maximum contraction at six months is 0.00068 in. per inch of length in 1:2:4 concrete, a figure which goes far toward accounting for the rupturing of many concrete structures even when temperature changes are negligible. If it is assumed that the ends of a concrete structure are rigidly held and the concrete is allowed to harden in air, the tendency toward shrinkage would immediately create a tensile stress in the concrete mass, and its amount at the end of six months would, if this were possible, be equal to 2,000,000 multiplied by 0.00068, or 1360 lb. per square inch, if the modulus of elasticity is assumed to equal 2,000,000 lb. per square inch in tension. Concrete is capable of withstanding only from 100 to 200 lb. per square inch in tension, so that even where there is absolutely no temperature change, it is impossible for a plain concrete construction to remain intact when enough resistance is offered to its free contraction due to drying. The decrease in length of a mass of concrete 100 ft. long due to the drying out of the moisture would be about 0.81, or roughly ¾ in. To cause the same amount of contraction, a fall in temperature of 124°F. would be necessary, but this is a range in temperature which few concrete structures receive. It would seem, from the above figures, that the temperature changes in some concrete structures play but a secondary rôle in the production of cracks.

A test was likewise conducted on a specimen of 1:2:4 concrete reinforced with ½-in. round rods placed 1 in. apart and extending the entire length of the test-piece. The contraction of the concrete in this case amounted to 0.0003 in. per inch of length, as compared with about 0.00068 in. in the corresponding unreinforced specimen. The steel in this specimen is undoubtedly receiving high compression from the results of the shrinkage of the concrete.

In obtaining the change in length of concrete under water, the specimens were first allowed to harden for two days in air, then measurements were taken with the micrometer. After measurement, they were immersed in water in a horizontal position, and, in order to permit their free expansion, they were laid on rollers. The results of the measurements showed that in every mixture of concrete tested, a decided expansion took place. At the end of three months, the specimens were still expanded and exhibited at that period a change of approximately 0.0001 in. per inch of length —a value from one-fourth to one-sixth of the contraction of the same kind of concrete when stored in air. After about one month, the length of the specimen remains practically constant, as nearly as can be judged from the results of the micrometer measurements.

When the ends of a concrete structure are fixed, the tendency toward expansion will be resisted with a resulting compressive stress at the end of three months of 2,000,000 multiplied by 0.000075 or 150 lb. per square inch.

It thus becomes plainly evident that when concrete which is continually wet is prevented from free expansion, it may receive high initial compresson from this cause. It is likewise evident that the steel in reinforced concrete beams may be subjected to high initial tension from the effects of this expansive tendency.

Measurements were also taken on specimens which were kept wet for about two weeks by means of a covering of wet burlap, and were then allowed to dry out. It was noted that, just as soon as the specimens were allowed to dry, they began to contract, and the ultimate amount of contraction was in excess of 0.045%. When specimens which have contracted through drying are immersed in water, expansion again takes place.

The combination of water with the cement, with the resulting formation of colloids or gelatinous bodies having greater volume than that of the cement in its untreated condition, may account for some of the expansion. When the water is allowed to dry out from the concrete mass, the colloids shrink in volume owing to the loss of water, and the concrete mass therefore shrinks. It is not at all improbable that the expansion and contraction of the rock aggregate due to the change in moisture content is also of influence in causing a change in the length of the concrete mass of which it is a component.

These tests serve to explain the cause of many defects in concrete construction, and

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may suggest means for rectifying them. The fact that a concrete wall 100 ft. long might shrink ¾ inch in length due to drying, clearly explains the presence of cracks in many such structures. In the case of a concrete roadway provided with expansion joints every 50 ft., each section is liable to shrink ⅜ in., due to the drying out of the moisture from the concrete, and this is again sufficient reason for cracking, considering the frictional resistance offered to free movement between the concrete and the foundation.

Many sidewalks divided into blocks and made with a top wearing coat of rich mortar laid on a concrete base, become dished in appearance in a short time. This phenomenon is readily explained by the fact that the rich mortar top coat contracts a great deal more than the concrete base, which may even be expanded owing to the retained moisture absorbed from a poorly drained foundation. The fact that the surface coat has a higher coefficient of expansion and contraction, owing to wetting and drying, than the concrete, is sure to produce a shearing stress between the two coats which tends to separate them, with the resulting destruction of the surface. Disintegration of this character is often noticed in pavements in which the bond between the wearing coat and concrete is weak because the wearing surface has been laid after the concrete base has hardened.

It has been noted that structures of concrete made to contain water, leak when allowed to dry out, but when again filled become water-tight. The leakage in a great many instances may be ascribed to the formation of cracks due to shrinkage rather than to the porous condition of the concrete itself. When the concrete again becomes wet, it expands in length, the fine cracks are closed, and the leakage is stopped.

If during a period of six months the temperature of a concrete mass falls 100°F., each inch of length will contract 0.00055 in. If, at the same time, the mass dries out, each inch of length might shorten by 0.00068 in. The total contraction will be 0.00055 plus 0.00068, or 0.00123 inch. A hundred-foot length of concrete might possibly shorten, therefore, as much as 1200 multiplied by 0.00123, or 1½ inch. In large masses of concrete where the heat generated by the chemical activity of the cement in hardening has a chance to accumulate, there will be an additional contraction due to the subsequent loss of this heat, which must be taken into account.

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## A Study of Load-Factors*

**By S. A. FLETCHER**

THE ideal condition of operation for a commercial electric generating station is that of supplying a uniform load during the whole 24 hours of every day equal to the capacity of the plant. This ideal is unattainable under practical conditions, and even a close approach to it is possible only under very special conditions. For instance, a number of the hydro-electric power stations at Niagara Falls furnish energy principally to electric furnaces, electrolytic works, etc., and hence have a very uniform load. The ordinary central station, however, has considerable variation in power requirements during the day.

The load conditions of a generating station may be represented graphically by a curve, each point of which represents the actual load at a given time. A load curve of a central station which supplies power mainly for commercial lighting is characterized by a high peak during the early evening, tapering down to a very low value after midnight and continuing at a comparatively low value until the next evening peak. Such a plant is said to have a low load factor; that is, the ratio of the average to the maximum load, as shown on the curve, is low. The revenue of such a station can be largely increased, with the existing equipment, if a market can be found for power during the period of small demand, that is, by filling in the valley of the curve.

The average daily load conditions on a

*Abstract from *The Electric Journal*, September 1912.

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certain 800-kw. steam turbine station in the first week of December are shown in Fig. 1. The characteristics of this station are indicated in Table I. The average output for 24 hours was 335 kw., and the maximum output 700 kw., making the load factor 47.9%. The lowest part of the load curve occurs usually from 11 p.m. to 7 a.m., and motor load during this time is thus especially desirable.

TABLE I—CHARACTERISTICS OF A TYPICAL LIGHTING STATION.

| | |
|---|---|
| Rated capacity of station, kw..... | 800 |
| Overload capacity of stations (50% for 1 hr.), kw..... | 1,200 |
| Turbo-generators (two units)— | |
| Capacity of first unit, kw..... | 300 |
| Capacity of second unit, kw..... | 500 |
| Maximum peak— | |
| Summer, kw..... | 600 |
| Winter, kw..... | 800 |
| Boilers, capacity (one spare), hp.... | 350 |
| Coal, bituminous run-of-mine, 13,500 b.t.u.— | |
| (hand firing, natural draft) per ton | $2.25 |
| Condenser (surface type) vacuum, in. | 27.5 |
| (Condensed steam returned to boilers.) | |
| Steam consumption (dry saturated)— | |
| Full load, lb. per kw.-hr..... | 20 |
| Average load, lb. per kw.-hr..... | 22 |
| Evaporation, lb. of water per lb. of coal ..... | 7 |
| Coal consumption, av. lb. per kw.-hr.. | 3.13 |
| (No extra allowance for banking fires. No charge for cost of make-up water.) | |
| Cost of station complete @ $125 per kilowatt .....| $10,000 |
| Labor and supplies, per year— | |
| Two 12-hr. shifts with extra fireman's helpers[1] for peak load ($600 per year) ..... | $7,300 |
| Fixed charges per year, per cent..... | 15 |
| (Interest 5%, taxes 1.5, running repairs 1.5, depreciation 4.5, and executive 2.5%. Depreciation is here considered as an amortization fund based on 15-year life, 6.66% depreciation at 5% interest compounded semi-annually.) | |

Night load can be obtained by installing motors in municipal and private pumping plants, newspaper printing offices, electrochemical works, cold storage rooms, and by charging storage batteries, etc. From 7 a.m. to 5 p.m. almost every industry where power is required offers possibilities for motor installations that will raise the load curve, increase the load factor, and reduce the average cost of producing a kilowatt-hour.

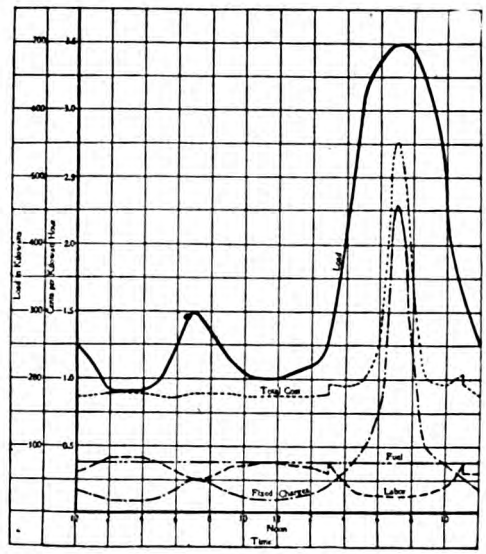


FIG. 1. LOAD CURVE AND CURVES SHOWING TOTAL AND DETAILED COSTS PER KILOWATT-HOUR, DISTRIBUTED CONTINUOUSLY.

In order to interest power users it is usually necessary to show the advantages of electric drive. While there are many advantages which might be enumerated, this discussion is limited to that of cost. Low power rates are not only attractive to prospective customers, but in many cases can be quoted with profit by the power company. There are a number of ways of distributing the costs of power generation and distribution, and each of the more common methods may be said to have its advantages. The method outlined in the following discussion, while not the most common, is one that is receiving considerable attention at the present time, and can, of course, be used in the laying out of schedules of rates made up on any other principle. The calculations are based on power cost at the switchboard; rates to customers must be based on these costs plus the cost of distribution. In fixing

[1]For conditions as shown in curves, Fig. 5 and 6, an additional fireman's helper is required in the boiler-room.

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rates to lighting customers, the investment in transformers and meters and the cost of reading the latter must also be considered. This consideration tends to make the rate for energy delivered on the customers' premises for small lighting installations higher than the rate for motors or large lighting installations, although the cost at the switchboard may be the same in both cases.

charges. For very low load factors, such as exist in plants having a lighting load only, the fixed charges form the greater part of the total cost per kilowatt-hour.

In the plant under consideration, the period during which the load exceeds the average load lasts about 8 hours; or from 3 p.m. to 11 p.m. (during the summer the duration of this peak is still shorter). The

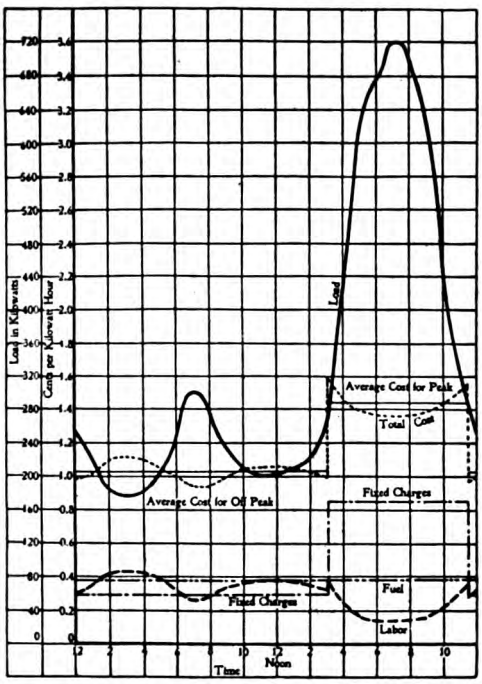


FIG. 2. LOAD CURVE AND CURVES OF COSTS PER KILOWATT-HOUR.

(Fixed charges distributed according to units in operation.)

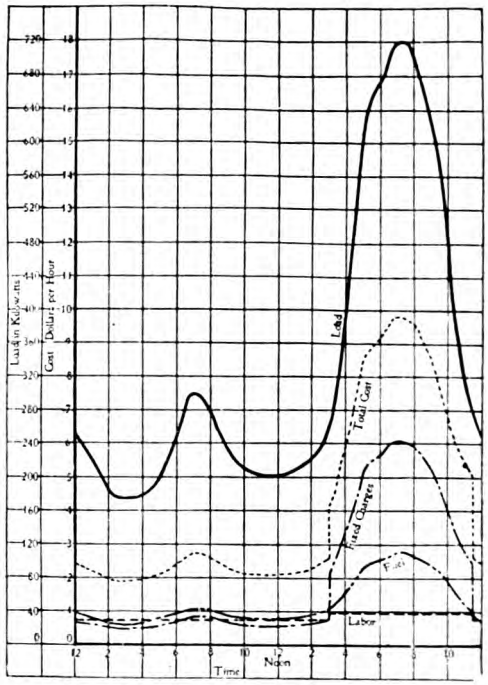


FIG. 3. LOAD CURVE AND CURVES OF COSTS PER HOUR.

The cost of manufacturing power is made up of two parts; the fixed charges, which depend on the investment, and the operating charges, which vary with the amount of power manufactured. The fixed charges include interest, depreciation, taxes, and insurance. The operating charges include labor, fuel, water, oil, and waste, etc, which, although they vary somewhat with the electrical energy generated, are by no means proportional to it. The ratio of the fixed to the operating charges depends upon the size and nature of the installation and also on the plant load factor. As a general rule, unless the load factor is over 30%, the fixed charges will equal or exceed the operating

station capacity must be large enough to carry the peak, and some generators must either be idle or running at reduced load during the remainder of the 24 hours. As each kilowatt of capacity requires a certain investment necessitating a fixed charge, it follows that the revenue per unit of capacity should be the same whether a generating unit supplies power for 1 hour or 24 hours. On this basis the fixed charge per kilowatt-hour of the equipment which works continuously is very much less than for that which works only on the peak. Therefore, the fixed charge is divided so as to make each kilowatt of capacity bear its share of the fixed charge, the amount per kilowatt-hour being determined by the number of kilowatt-hours generated by each kilowatt of capacity.

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The kilowatt-hour costs of fuel, labor, and fixed charges are shown in Fig. 1, as well as the total cost. The fuel cost per kilowatt-hour (which may be assumed to include water, oil, waste, etc.) is assumed to be constant regardless of load, a condition very nearly true when two or more units are installed and each unit may be operated at approximately a uniform load. The labor cost per kilowatt-hour decreases with increasing load, and is therefore at its lowest value during the peak. The fixed charges are divided as explained in the foregoing paragraph, the larger being distributed over the time of the peak.

While Fig. 1 shows what may be called the instantaneous costs per kilowatt-hour,

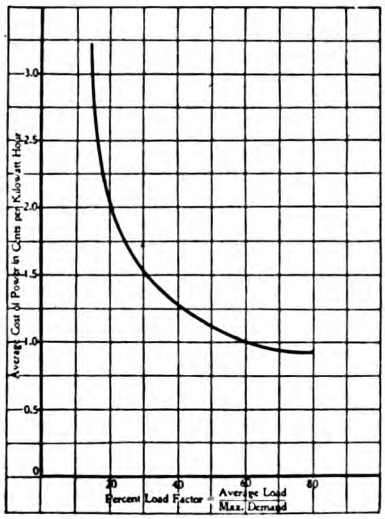


FIG. 4. CURVE SHOWING VARIATION IN COST WITH DIFFERENT LOAD FACTORS.

the determination of such curves is difficult, so that for use in figuring costs it is preferable to adopt a slightly different method of distributing the fixed charges. The peak load makes necessary the greater portion of the investment, and the fixed charges per day on that portion of the plant used only for the peak should therefore be distributed over the time during which the peak continues. The 300-kw. unit operates 24 hours and the 500-kw. unit operates but 8 hours. The 300-kw. unit causes three-eighths of the total fixed charge and the 500-kw. unit five-eighths. Thus, from the output of each unit the average fixed cost per kilowatt-hour may be figured. This makes the interest charge per kilowatt-hour constant during both the period of light and of heavy load, as indicated in Fig. 2, and therefore provides a system of determining the costs which is more readily used than the method shown in Fig. 1. All of the following curves will be based upon the method used in Fig. 2.

The total charges vary as affected by the fuel, labor, and fixed charges, the average total charge being 1.43c. per kilowatt-hour during the peak and 1.025c. during the remainder of the day. During the hours of low load, idle generating capacity is available; with fixed charges distributed as shown in Fig. 1 or 2, the cost of off-peak load depends almost wholly on operating charges and is therefore low. In Fig. 3 the load curve is repeated and the hourly cost of all energy as well as that of the component parts, labor, fuel, and fixed charge, is shown. These hourly costs are obtained by multiplying the cost per kilowatt-hour by the average load at various times.

The decreased average daily cost of energy per kilowatt-hour with increased load factor is shown graphically in Fig. 4. The general shape of such a curve is the same for all plants, although the scale values may differ. This curve makes clear the fact that increasing the load factor by securing off-peak load decreases the cost of all energy during the 24 hours. This fact is made still more clear by Fig. 5 and 6, obtained by increasing the load factor on the station previously considered. The load curve shows practically the same maximum peak as before, but shows also the addition of a day load. The former station capacity is still ample, but the load factor has been raised to 63%, a value easily possible for many stations.

Special attention is called to the fact that not only the average total cost per kilowatt-hour has been lowered, but also the average is less in both the period requiring the full generating equipment and in the period requiring only the smaller unit. These curves would show a somewhat decreased total cost if the actual hourly fuel consumption had been taken instead of assuming that the fuel cost per kilowatt-hour is constant regardless of the load.

If it were possible to maintain nearly full load upon the station at all hours, that is, to operate with a load factor approaching 100%, the total cost per kilowatt-hour would be

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maintained practically constant at the minimum value obtainable in this plant. When the lighting load is charged with the fixed and operating expense, a good off-peak load can be made to pay substantial dividends at a very moderate selling price.

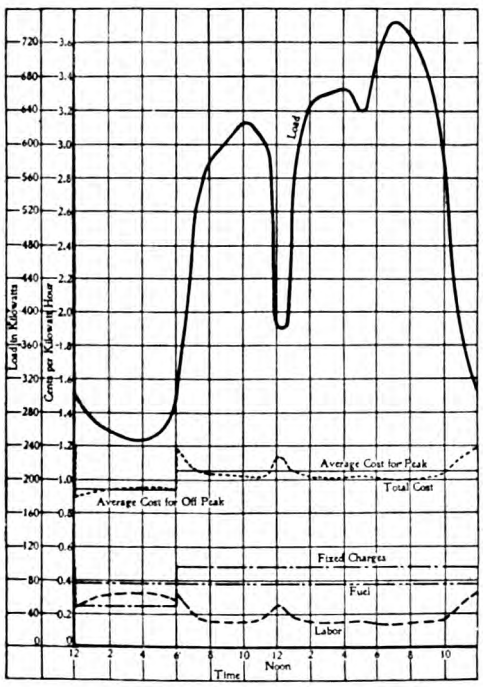


FIG. 5. LOAD CURVE AND CURVES OF COSTS PER KILOWATT-HOUR WITH LARGE DAY LOAD. (Compare with Fig. 6.)

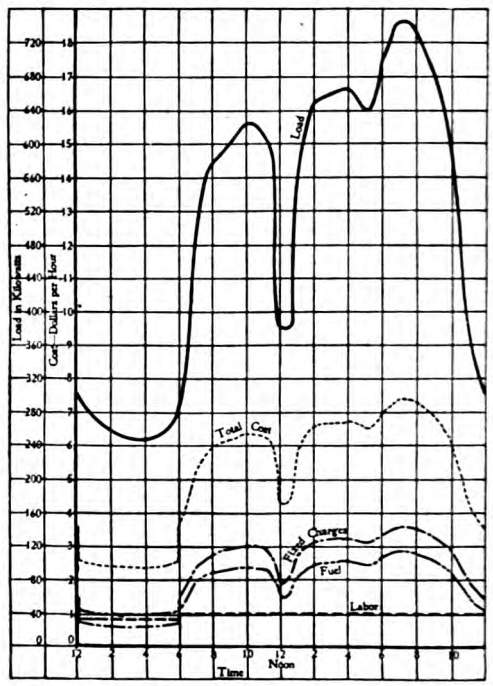


FIG. 6. LOAD CURVE AND CURVES OF COSTS PER HOUR WITH LARGE DAY LOAD. (Compare with Fig. 5.)

## Hydro-Electric Development on Big Creek, California*

A HYDRO-ELECTRIC project designed for an ultimate capacity of 120,000 hp. is at present under construction in central California at a point 275 miles northwest of Los Angeles and 175 miles southeast of San Francisco. The project is being developed by the Pacific Light & Power Co., which operates at present six hydro-electric and three steam electric-generating plants in southern California, having an aggregate capacity of somewhat over 70,000 kva. and serving a population of over 400,000. The work comprises the construction of three impounding dams and two independent power-plants, the latter being connected by steel penstocks and rock tunnels.

A short distance above the falls, at an elevation of 6800 ft., is a natural basin which will be converted into a storage reservoir, having a capacity of 100,000 or more acre-feet. The watershed drained by Big creek has an area of about 80 square miles, and the annual rainfall in this territory is estimated at over 80 in. for an average year. The run-off is equivalent to at least 50 inches. The waters of Big creek will be impounded by three gravity section concrete dams, two 100 ft. in height, and one 165 ft. in height. The dam will be built upon solid granite formation, all of the material for construction, aside from cement, being close at hand.

From the reservoir the water will be led through a 4000-ft. tunnel cut through solid

*Abstract from *Engineering Record*, September 14, 1912.

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granite. From the outlet of this tunnel the water will be carried for 6800 ft. farther through a closed steel flow-pipe to the brow of the hill above the power-house, and thence through steel pressure-pipes it will drop about 2100 ft. into power-house No. 1. After passing through power-house No. 1 the water will enter the forebay of a second tunnel. For this forebay use will be made of the natural bed of the creek by constructing a dam 70 ft. in height. This tunnel will be cut through solid granite for a distance of 21,000 ft. From this outlet the water will pass through pressure-pipes leading 1900 ft. below to power-house No. 2. From this point the water will be returned to the natural bed of Big creek. The forebay of the second tunnel will be placed just below the junction of Pitman creek and Big creek. The added supply of water will increase the power available at power-house No. 2, and compensate, in a measure, for the difference in static heads at the two power-houses. It will therefore be possible to realize approximately the same output from each of the plants.

With the extremely large difference in elevations, a comparatively small amount of water is necessary for power development, and with the reservoir capacity to equalize the flow of the stream, it will be possible to realize ultimately 120,000 kw. With no water flowing into the reservoir it will probably be possible to operate both plants for 150 days on storage, assuming a 50% load factor. The two power-houses will be built of reinforced concrete. Each will have an ultimate capacity of 60,000 kw., with four units, of which two will be in the initial installation. Each station will be capable of operating without the other in case of necessity. The generating units will consist of 3-phase, 6600-volt generators, driven by two overhung impulse wheels mounted on the same shaft. The combined capacity of the two wheels of each unit will be 20,000 hp. The current from the generators will be stepped up to 150,000 volts for transmission. The transmission line will lead 275 miles southwest to Los Angeles, and will consist of a double set of steel towers, each supporting three steel-cored aluminum conductors arranged in a horizontal plane. The transmission lines will be erected on private property for a large part of the distance.

At Los Angeles a sub-station, equipped with synchronous condensers and step-down transformers, will convert the energy to a voltage suitable for delivery over the existing distributing systems. Before work on the main power development could be commenced it was necessary to build a 56-mile construction railroad from a point on the Southern Pacific, 22 miles north of Fresno, to the site of the storage reservoir, just above the falls of Big creek. This road is standard gauge and runs on a private right-of-way for over half its distance to the point where it enters the Sierra National Forest Reserve and begins its heavy climb into the mountains. The maximum grade is 5%, and the maximum curvature 60 degrees.

Railroad yards have been installed at the side of power-house No. 1, and here the track connects with a standard-gauge incline hoist, which reaches to the basin on the hilltop. Seven miles of tracks connect the camps, storehouses, dam sites, and gravel pits. The road was built in 165 days, probably a record for railroad construction through such rough country. It is estimated that over 50,000 tons of material will be taken into the job for the initial development and 100,000 tons for the total installation. The engineers on the work are the Stone & Webster Construction Co., Boston, who are handling all construction.

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# Probable Order and Cost of Construction of Hetch-Hetchy Works*

By JOHN R. FREEMAN

THE following assumes the purchase of the Spring Valley Water Works and is subject to change after further study of the different districts. The work of first necessity will probably be the extension of distributing mains in accordance with the results of a study recently made by the city engineer, but these extensions, as also the building of the San Miguel reservoir and various problems of extension to meet the growth of Oakland, Berkeley, San Mateo, and other communities, are essentially local problems, for which the solution would of necessity be about the same whatever source was adopted. The present study is directed more particularly to the supply of water than to its distribution, and until the organization of the metropolitan water district has been accomplished, our problem chiefly relates to San Francisco.

*A New Transbay Pipe.*—For this, the work of first necessity is the building of the Bay Head section of the aqueduct between Crystal Springs reservoir, across from Ravenswood to Dumbarton point, past the Irvington gate house and into the Sunol valley. At present there is but a single pipe leading to the city from all the transbay sources, and this pipe is understood to be already taxed to the limit of its carrying capacity. Since nearly half the water which San Francisco now uses comes through this pipe, and since the practicable sources for any important additional supply are believed to all lie across the bay, the importance of immediately constructing this new pipe is plain. The cost from the Calaveras junction to the Crystal Springs reservoir, for a pipe conveying 100,000,000 gal. per day, and three miles of tunnel near Mission San Jose, large enough for 25 to 50 years to come is $4,805,000. This cost can be lessened materially by making this pipe only 50,000,000 or 60,000,000 gal. capacity per day instead of the 100,000,000 gal. per day designed to utilize the gravity flow in making possible large areas of truck farming in this region and providing for future growth.

*The Calaveras Reservoir.*—An additional supply of water to feed this new pipe shall meanwhile be in progress. The supply that would cost the least in the long run (although not most attractive in quality by reason of storage in warm climate) would be that obtained by building the proposed Calaveras dam, which work would probably take two years, although it might possibly be crowded into a single year since the explorations and designs are practically complete and the situation lends itself to the manufacture and deposit of exceptionally large quantities of cement concrete daily. Considerably more than one year's ordinary run-off would be required to fill this reservoir, which, like the Crystal Springs, is planned with volume large in proportion to its catchment, with a view to maintaining it principally for an emergency reserve. The estimated cost of this Calaveras dam to the full height of 793 ft. above mean sea-level, storing 46,000,000,000 gal., is about $2,500,000.

The gaugings of Calaveras creek have been so crude that the yield of its watershed is uncertain. Probably within a year or two after the completion of the dam, with average rainfall and with Alameda creek diverted into it by a canal, this reservoir would yield an average of 20,000,000 gal. per day throughout the year, possibly more. This quantity would supply the increased demands of the San Francisco district, including whatever may be needed for Oakland, San Mateo, and other communities, for a term of perhaps five years. Also, possibly 5,000,000 gal. per day could be continuously obtained for a few years by deep pumping from the gravels above Pleasanton and Livermore, disregarding the rate of replenishment, and this ground-water could be had very quickly in case of shortage. There are, however, contingencies more or less remote of local interference from the Niles Cone property owners, and there is believed to be a strong popular demand for the soft and pure mountain water which may override the fact that the beginning of

*Abstract from Report of July 15, 1912.

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the large burden of interest on the Hetch-Hetchy aqueduct might be deferred five years. As to the risk of shortage before water could be brought from the Tuolumne if the Calaveras dam were not built, the present indications are that this would not be serious and that emergency measures would prevent any disastrous shortage. The cycles of extreme low rainfall come only once in every ten to twenty-five years. Crystal Springs reservoir is now nearly full and alone holds one and a half year's supply at the present rate of consumption. The deeper gravels near Pleasanton could without permanent injury be deprived of their water at a rate more rapid than its annual inflow for a few years, leaving the depletion to be replenished after the aqueduct was extended. The ample storage of the Crystal Springs reservoir permits time for applying remedies, and commonly there can be a quick reduction of 10% in a city's water consumption without injury through a campaign against water waste; or probably a reduction of about 20% could be had by universal metering, as in Oakland, Berkeley, and Alameda, last year, which towns were fully equipped with meters within seven months and a saving of 25% effected.

While it appears certain that there would be less total expenditure of money by deferring the extension of the aqueduct to the Early intake while successively building the reservoir at Calaveras, Antonio, and Valle,[1] also meanwhile drawing to the utmost on the Pleasanton and Livermore gravels, there are advantages on the other side. For example, the superior softness of Tuolumne water would probably save the metropolitan district about $175,000 per year in soap alone, and five years' pleasure in the use of this softer and purer water for drinking and bathing is worth something to three-quarters of a million people. An abundance of pure mountain water would help attract business to these cities.

*Aqueduct Tunnel, Sunol Valley to the San Joaquin Valley.*—This is the most difficult portion of the entire Hetch-Hetchy project and will require the longest time to construct, by reason of the deep shafts and the long distance between them, and the time necessary for constructing these 28.3 miles in length of tunnel 12 ft. 8 in. diameter and lining it with concrete sets the limit to the earliest date at which the Hetch-Hetchy water could be made available, therefore it is obvious that this portion should be the most vigorously attacked when the extension toward the Sierras is begun. There is no tunnel on this line more difficult or longer between shafts than the Elizabeth tunnel of the Los Angeles work, which was holed through in 40 months. Whether these 28.3 miles of tunnel between Sunol and the San Joaquin are built within three and one-half or seven years is chiefly a question of organization, plant, and good management. The recent developments in electrical haulage in mines have made possible much more rapid progress with long drifts, and on the Elizabeth tunnel it was found that speed and cost were not affected materially by a distance of two miles from the portal.

While this tunneling is going on, the construction of the Sunol siphon and the 8.3 miles of steel pipe between the San Joaquin river and the Tesla portal should be completed, thus assuring a supply for temporary purposes from the San Joaquin by pumping in case of an emergency. The confluence of the Stanislaus with the main river near the point of crossing and the entrance of the Merced a short distance upstream assure for some years to come certainty of a supply of water at this point. Across the San Joaquin valley the line should also be pushed to a date of completion coinciding with that of tunnels between Sunol and Tesla. At the same time work should be going on in tunneling from the easterly edge of the San Joaquin valley to the Tuolumne crossing at Red Mountain bar, and simultaneously also the tunnel from Red Mountain bar to Moccasin creek should be in progress.

Here at Moccasin creek it would be feasible to arrest the tunneling for some years and take a supply by means of a temporary side-hill canyon, conduit, or wood-stave pipe projected along the contour line up the Tuolumne to near Rough and Ready creek, where a low diverting dam would pick up the water released at the storage dams back

[1]The available yield from each of these reservoirs is today uncertain. Accurate measurements of the water resources at each of these sites and in the ground-water regions should be begun at once by recording stream gauges, recording rain gauges, and the constant work of a skilled hydrographer.

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in the mountains. Such a project would be directly comparable in value and efficiency with several of the alternative projects that have been proposed. The water being delivered into the upper end of the Crystal Springs reservoir would have far more efficient detention for safeguarding the domestic supply against disease germs than is offered in connection with the McCloud, Stanislaus, Mokelumne, American-Cosumnes, Feather, or Yuba rivers. But it is believed advisable and worth the extra cost to carry the Hetch-Hetchy aqueduct farther upstream to the point designated as Early intake, planning the work so as to complete it to this point at the same time with the Coast Range tunnel between the Sunol valley and the Tesla portal and to begin the supply to the cities from the Early intake. The tunnel from the Early intake easterly to the Hetch-Hetchy dam, should be built as soon afterward as convenient, perhaps within five years, although it will add nothing to the volume of water obtainable and will improve its quality by preventing turbidity for only a few days in the course of the year. With this completed and with this pipe-line modified as explained below, the cities will then have mountain water by quick transit from the main Hetch-Hetchy reservoir, which has not been exposed anywhere in its course to the possibility of contamination or to the growth of such organisms as are promoted in reservoirs by the action of sunlight and warmth.

*Cost of Hetch-Hetchy Supply.*—It is estimated that the cost of developing this system step by step as above described will be as follows. These estimates have been made with a painstaking attention to detail seldom attempted in preliminary work of this character, and the figures are also set forth open to the examination of citizens and the promoters of rival projects with uncommon fulness in order that the matter may be fully discussed and every part of the data for these cost estimates made plain. In reviewing the costs for the various divisions it should be clearly kept in mind that several of those divisions set forth alternative projects, only one of which would be adopted and in order that the structural advantages of the more expensive types of aqueduct may be properly balanced against the economics of cheaper types.

The following are estimated costs of the several portions of the work, arranged in order of date and of proximity to the city, although work will be going on simultaneously in many places all along the line.

The figures include contractor's profit, headquarters expense, interest during construction, and all of the items included in the final figures.

(*a*) Steel pipe 4.5 ft. net diameter, 24.3 miles long, capacity about 50,000,000 gal. per day, varying according to slope, from San Miguel reservoir or University Mound reservoir to the Redwood City manifold gate house, estimated cost ..... $1,861,000

(*b*) From Redwood City manifold gate house to Irvington gate house, cement lined steel pipe, net diameter 6.5 ft. capacity 100,000,000 gal. per day, with slope of 0.85 ft. per 1000, or 4.5 ft. per mile, built across the flooded marsh lands either on concrete piers or upon an earth embankment, as may prove most expedient on further study and for the mile of crossing at the head of the harbor to be either submerged in a dredged channel or to be carried on concrete piers above the water-level not far from the present line of the railroad trestle to a short submerged section corresponding in location to the railroad draw-bridge, total length 16.7 miles, estimated cost. 2,682,000

(*c*) Branch line steel pipe 4.5 ft. diameter from Redwood City manifold gate house into the head of Crystal reservoir, about 3.6 miles in length, capacity 50,000,000 gal. per day, under 7.0-ft. slope per mile, variable to meet conditions, estimated cost ..... 434,000

(*d*) From Irvington gate house, 3.2 miles of tunnel 12.8 ft. diameter (400,000,000 to 500,000,000 gal. capacity per day), under mountain at Mission San Jose to Calaveras junction in the Sunol valley ..... 1,133,000

(*e*) Calaveras junction across Sunol valley, 0.85 miles of cement-lined steel pipe siphon, 8.75 ft. net diameter, cost..... 122,000

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Note.—A wood stave temporary pipe, say 3 ft. diameter, could be quickly laid to this point from above Pleasanton to take water temporarily from a new set of wells into the above new transbay pipe, if Calaveras reservoir is not built and a water famine is imminent.

(*f*) From Sunol valley to Tesla portal, 27.5 miles in length, 12.8 ft. diameter, future capacity 400,000,000 to 500,000,000 gal. per day, cost ..... 10,262,000

(*g*) Cement-lined steel pipe 7.5 ft. net diameter, from Tesla portal to the San Joaquin river crossing, 8.3 miles, capacity 240,000,000 gal. per day, with 10-ft. slope per 1000..... 1,211,000

(*h*) 36.6 miles of cement-lined steel pipe crossing San Joaquin river to tunnel portal southeast from Oakdale, 7.5 ft. net diameter, capacity 240,000,000 gal. per day, under 10-ft. drop per mile, cost ..... 6,291,000

(*i*) Tunneling from San Joaquin valley to Tuolumne crossing at Red Mountain bar, 10.25 miles, 12.8 ft. diameter, capacity 400,000,000 to 500,000,000 gal. per day.... 3,168,000

(*j*) Tuolumne river crossing, steel pipe siphon, cement lined, 10 ft. net diameter, 0.4 miles long, with support ..... 182,000

The pump lift from river into tunnel portal here would be 285 ft., but the river is polluted by mine waste from Wood creek.

(*k*) Tunnel 10 ft. diameter, concrete lined, capacity 400,000,000 to 50,000,000 gal. per day, 5.55 miles in length, Red Mountain bar to Moccasin creek power site..... 1,463,000

Sub-total from Mocassin creek power site to the reservoir in San Francisco .....$28,809,000

(l) At this point the supply could be temporarily taken from the river in case of emergency and delivered into Crystal Springs reservoir by means of a cheap type of cut and cover conduit 50,000,000 gallons per day capacity, from Moccasin creek power site to a point on the Tuolumne river near Wards ferry, 7.8 miles long. The probable cost, including low diversion dam, is estimated at about 275,000

A temporary open unlined canal for same distance could be built for less.

(*m*) Tunnel from Moccasin creek to the Early intake 10 ft. in diameter, all concrete lined, including works at Early intake and chute at Moccasin creek, total length 19.5 miles, capacity 400,000,000 to 500,000,000 gal. per day, under slope of 8 to 10 ft. per mile, cost ..... 5,404,000

(*n*) Estimated cost of low Hetch-Hetchy dam, storing 40,000,000,000 gal., including preparation of reservoir; dependable yield, after satisfying all irrigation priorities, 160,000,000 gal. per day... 1,138,000

(*o*) Cost of easy-grade highway, temporarily occupied by railroad from Roasasco to the Hetch-Hetchy dam, 62 miles..... 1,288,000

(*p*) Roads to tunnel shafts on Coast Range divisions, additional 36,000

(*q*) First installment scenic road in Hetch-Hetchy valley, about 10 miles long, comprising road on north side of valley to point opposite confluence of Tiltill creek, and on south side of valley upstream to the head of flowage; also easy-grade wagon-roads to Lake Eleanor and Cherry creek, laid out with a view to scenic advantages ..... 306,000

Total cost of supply, varying from maximum of 240,000,000 gal. per day to minimum of 160,000,000 gal. per day in extreme drought delivered to Irvington gate house, overlooking San Francisco bay, with 50,000,000 gal. delivered into San Francisco three miles from city hall, and 50,000,000 gal. into Crystal Springs reservoir when desired .....$36,981,000

And also with 60,000,000 gal. per day ready for Oakland, San Jose, etc.

(*r*) Cement-lined steel pipe, 4.5

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ft. diameter, from Irvington gate house, delivering 50,000,000 gal. per day as far as the city hall, Oakland ..... 2,247,000

The above 160,000,000 gal. per day would serve all needs and growth for the communities on both sides of San Francisco bay for a long time and also provide water enough for San Jose, San Mateo, etc.

*Desirable Extension for Utilizing Water Rights, Etc.*—Future successive steps for increase of quantity to a dependable minimum of 240,000,000 gal. per day.

(*s*) Unlined tunnel in granite, 8 ft. diameter, from Hetch-Hetchy reservoir to Eleanor and Cherry reservoirs ..... $1,144,000

(The above diversion may properly precede the building of large dams and can be effected by small earth and rock-fill dams, giving only 10 or 15 ft. head, very cheaply built.)

(*t*) Earth dams storing about 50-ft. depth of water at Lake Eleanor and Cherry creeks, exclusive of cost of water rights already paid for..... 1,170,000

(*u*) Low masonry dam for flooding Poopenaut Meadows and giving additional storage to elevation ..... 898,000

The above works will give a dependable supply of 240,000,000 gal. per day delivered to Irvington gate house in driest years and comprise all of the water supply-works needed for the next 30 or 40 years, after which higher dams would be needed; also a second steel pipe across the San Joaquin valley, with which pipe added 400,000,000 gal. per day could be delivered on the shores of San Francisco bay.

Expenditures already made by the city of San Francisco for lands and water rights at Hetch-Hetchy, Eleanor, and Cherry reservoirs...$1,236,000

The value of the opportunity for future power development will far more than provide for extension of tunnel from Early intake to the Hetch-Hetchy reservoir and for the extension of dams and further development of storage as needed to the full amount of 400,000,000 or 500,000,000 gal. per day.

The remarkable fact appears that the estimated cost of the Freeman project bringing a minimum supply of 160,000,000 gal. per day, in the driest year, including scenic road and permanent highways, and with opportunity conserved for future vast power development, costs less than any of the 60,000,000 gal. per day plans heretofore proposed, and moreover avoids all the expensive upkeep of pumping stations.

It is this fact that has prompted a careful review of the figures and setting them forth in detail for examination by other engineers.

*The Loading Applied to Unit Costs.*—In reading preliminary estimates for this class of work I have sometimes found it hard to make certain that the unit costs for tunnels and aqueducts, at so much per lineal foot, had been properly loaded with the various items of general expense, which seldom are reckoned into the monthly estimates made in the field while the work is in progress and which partial cost often becomes quoted as the cost of the work.

*A Prudent Basis of the Estimates.*—When one takes into account the fact that this work is all figured on the basis of an eight-hour day, from similar work under California conditions, and that the city is in a position to 'buy this experience' from men who have spent years on other similar work now drawing to a close, and that 15% is added over and above the Los Angeles cost in the form of 'contractor's profit,' and that other assumptions have been made with liberality, I believe it is feasible, with good management and wise legislation, to build the work within the estimated cost. Unwise legislation and poor management might easily add $5,000,000 or more.

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# Plant Efficiency*

By J. D. ROSS

THE following paper is an analysis of the losses and efficiencies of the Seattle municipal light and power plant for the year 1911.

Great care has been taken in these measurements and the results have been checked in as many ways as possible and instruments have been frequently calibrated. These figures are therefore believed to be a close approximation to the true values.

The Seattle plant is a hydro-electric system delivering water to two 1500-kw. Pelton units and two 5000-kw. turbine units under 600-ft. (183 m.) head through two pipes approximately 3½ miles (5.6 km.) long, one of which is 67¾ in. (172 cm.) and the other 49 in. (124 cm.) inside diameter. The current is transmitted at 60,000 volts through two lines to Seattle, a distance of 38.7 miles (62.2 km.), and there distributed at 15,000 and 2400 volts for use by approximately 20,000 customers and for the city street lighting.

The 67¾-in. (172 cm.) pipe consists of 15,865 ft. (4835.6 m.) of wood stave pipe dividing at a point 951 ft. (289.8 m.) from the power-house into two 48-in. (122 cm.) riveted steel penstocks. The 49-in. (224 cm.) wood pipe joins onto a 48-in. (122 cm.) riveted steel penstock at a point 1008 ft. (307.2 m.) from the power-house. Careful tests were made on the 67¾-in. wood stave pipe, using gauges calibrated before and after. The pipe contains five steel elbows, where the curvature is greater than 20°. These elbows are made to a 15-ft. (4.57 m.) radius and have angles respectively 92, 55, 60, 65, and 45°. The loss in head of each elbow was measured by a differential pressure gauge. The results of the test are given in detail in the table on next page.

This pipe has been in operation since November 20, 1908. The loss in entry as given in the above table seems large and rises with the velocity more rapidly than it should. This is apparently due to the resistance of the screens, which are of wood bars. These were being changed before the test was made, as it was noticed at times of heavy load that there was a difference of level on two sides of the screens. The entry of the pipe is bell-mouthed. The total length of the wood pipe is 15,865 ft. (4835.6 m.) The line was designed for a slope of 4 ft. per 1000 ft. to give a velocity of 10 ft. (3.05 m.) per second.

The loss in the penstocks was computed from records taken by Bristol recording gauges at the generating station, which were frequently calibrated. The results so obtained were checked by computing the loss from the efficiency shown under test, and agreed very closely. The maximum output of the two penstocks was 12,400 kw., with a loss of 6%, and the average output for the year was 6009 kw., with an average loss of 2.3%. This loss was increased by the fact that the plant was supplied for 33 days in November and December by the larger pipe alone.

There are four units in the power-house, two of which consist of 8000-hp. Francis turbines direct-connected to 60-cycle, 2300-volt, three-phase generators rated at 4000 kw. at 35°C. rise, with a four-hour overload capacity of 5000 kw. at 40°C. rise. These units operate at 600 r.p.m. The other two units are driven by 2400-hp. Pelton impulse wheels direct-connected to 60-cycle, 2300-volt, three-phase generators rated at 1200 kw. at 35°C. rise. These units operate at 400 r.p.m. The wheels are each equipped with two runners, each of which is supplied from a needle and a deflecting nozzle. The combined capacity of the present installation is therefore 13,000 kw. on a 40°C. rating. The two machines last mentioned, however, exceed their rating and have been operated continuously without excessive heating at 1750 kw., making the combined capacity 13,500 kw. Three water-wheel exciter units are installed, two of which have a capacity of 75 kw. each, and the third 150 kilowatts.

As the efficiency of each unit varies with the load, and it is obviously impossible to have all generators that are in use at any

*Abstract from Proceedings Am. Inst. Elec. Engineers, May 1912.

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time carry their full load, the all-day efficiency of the generating station will depend on the number of units in use and the load which each carries, as well as on the power factor of the load, and, in the case of this plant, where two types of wheels are used, it will also depend on the proportion of the load that the operator gives to each type of machine. In general, the greatest all-day efficiency can be had by keeping the machines as nearly as possible at the load of maximum efficiency, and by shutting down the machines without load as far as can conveniently be done.

While the combined maximum efficiency of generator and wheel was found in the case of the 5000-kw. units to be 76.7%, and in the case of the 1500-kw. units to be 69.9%, the all-day efficiency of the plant for 1911 was found to be 56.7%. This does not include current for excitation and station lighting. By including this as a loss, the all-day efficiency of the plant drops to 55.7 per cent.

The reason for the difference in the same type of unit is found in the fact that the operators favor No. 1 and No. 4 machines, from habit rather than intention. The impulse wheels, being small, are operated under full load for a great part of the day and their all-day efficiency is greater than that of the turbines, notwithstanding the higher efficiency of the turbine sets at full load. It will be readily seen from these facts that the efficiency of a plant depends very largely on the way it is handled by the operator and during low-water periods it is possible to prepare a schedule showing which machines should be used for each load which the plant carries. This schedule will be modified by the conditions of the plant, changes in load, and regulation.

LOSS OF HEAD IN FEET IN VARIOUS PARTS OF 67½-IN. (172 CM.) WOOD STAVE PIPE

| Velocity in ft. per second | Loss in entry and screens | Elbow No. 1 92° | Elbow No. 2 55° | Elbow No. 3 60° | Elbow No. 4 65° | Elbow No. 5 45° | Total loss in pipe | Friction loss after deducting entry and elbows | Loss in 67½" stave pipe per 1,000 feet | Value of C. in Kutters formula | Value of N. in Kutters formula |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2½ | .06 | .03 | .03 | .03 | 03 | .01 | 4.1 | 3.91 | .246 | 134.06 | .01190 |
| 5 | .25 | .09 | .08 | .08 | 08 | .05 | 15.4 | 14.77 | .931 | 137.96 | .01175 |
| 7½ | .54 | .25 | .18 | .19 | 20 | .14 | 33.9 | 32.40 | 2.0425 | 139.71 | .01165 |
| 10 | 1.14 | .46 | .34 | .36 | .37 | 27 | 61.9 | 58.96 | 3.775 | 137.01 | .011865 |

NOTE: 1 ft. = 0.3048 in.

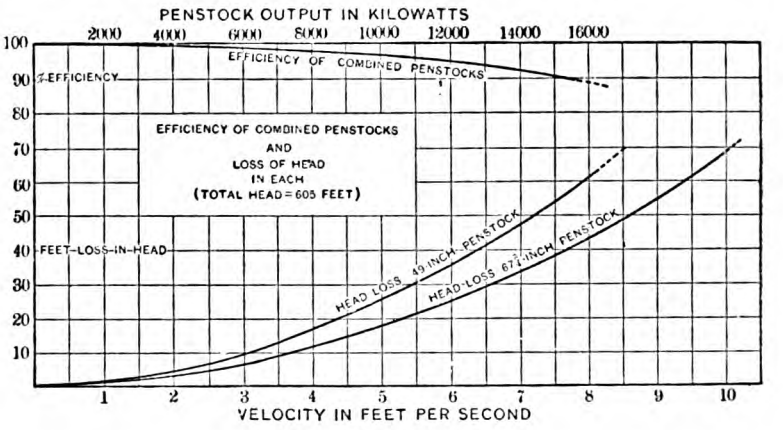


FIG. 1.

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Losses in the water wheels and generators were computed from the half-hour wattmeter readings on the generators as recorded in the station report. The input for each output throughout the year was computed from efficiencies shown in tests made in 1909 and checked at the end of 1911. The

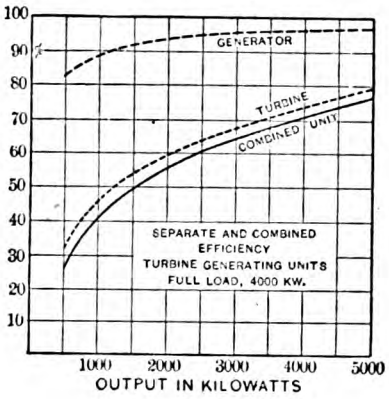


FIG. 2.

results show all-day efficiencies for the year as follows:

EFFICIENCY.

| | Wheel..... | Generator.. | Combined.. |
|---|---|---|---|
| Impulse unit No. 1.... | 70.8 | 93.0 | 65.8 |
| Impulse unit No. 2.... | 66.3 | 92.2 | 61.1 |
| Turbine unit No. 3.... | 57.1 | 93.0 | 53.1 |
| Turbine unit No. 4.... | 63.6 | 94.1 | 59.8 |
| Four units combined.. | 60.7 | 93.5 | 56.7 |

The higher efficiency of the impulse units is due to the fact that they were nearly always loaded above 900 kw., and the regulating was done with the relief valves and governors on the turbines, so that there was little loss from the deflecting nozzles. The power used in excitation was computed from the half-hour readings on the exciter outputs, and amounted to 399,120 kw.-hr. or 1.3% of the output of the generators. The water input to the exciter units, computed similarly to that of the large units, was 665,200 kw.-hr. Station lighting, including light for the employees' cottages, amounted to 175,000 kw.-hr. for the year.

The station is equipped with nine transformers. Each bank of three has a normal capacity of 4500 kw. at 35°C. temperature rise. These transformers step the voltage from 2300 to 60,000 volts, 3-phase star connected. The neutral of the star connection is grounded. The manufacturers were requested to sacrifice efficiency for high insulation, if necessary, but the efficiency is found to be as high as is customary when using lower insulation. These transformers were all in circuit continuously to keep them in good condition, and their core losses were practically constant, amounting to 926,000 kw.-hr., or an average of 11.7 kw. per transformer. The copper loss was computed from the readings on the reports, and amounted to 200,000 kw.-hr., or an average of 2.54 kw. per transformer.

| | Kw.-hr. | Av. kw. |
|---|---|---|
| Core loss ..... | 926,000 | 106 |
| Copper loss ..... | 200,000 | 23 |
| Total loss .....1,126,000 | | 129 |
| All-day efficiency ..... | 96.1% | |

There are two high-tension lines, 38.7 miles (62.2 km.) in length, strung on two different makes of insulators of practically the same size and type. One of the lines is of No. 2 solid medium hard-drawn copper, the wires being placed in a 6-ft. (1.83 m.) triangle. The other is built of No. 0000 seven-strand hard-drawn copper, the wires being placed in a 7-ft. (2.13 m.) triangle. The line loss was computed from the constants of the lines, taking the load data shown by the report sheets. The line re-

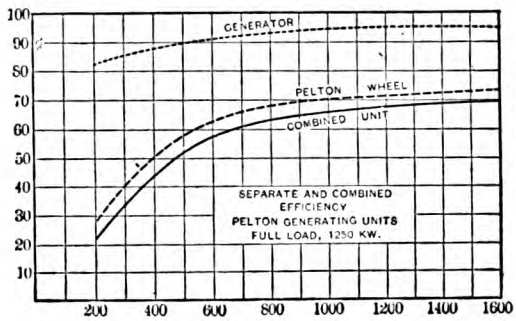


FIG. 3.

sistances were measured by direct current, using the fall of potential method, and agreed very closely with the computed value. The

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inductance and capacity were calculated from the values given in the Standard Handbook, third edition. To simplify calculation for the all-day efficiency, a Perrine-Baum regulation diagram was drawn for both lines in parallel. To this were added circles, taking as a centre the end of the substation voltage vector, and as a radius the square of the voltage drop in the line, multiplied by the conductance of the line. The radii

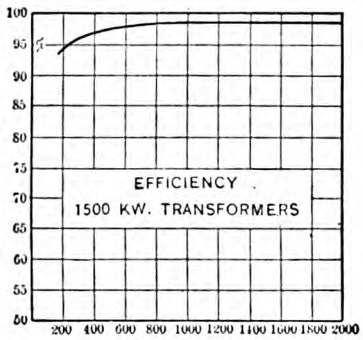


FIG. 4

of these circles represent power loss. The power lost during 1911 on the two lines, figured from this diagram, using the half-hour readings at the substation for load data, amounted to 378,000 kw.-hr., or an average of 43 kw. for the year.

| | Kw.-hr. | Av. kw. |
|---|---|---|
| Line loss ..... ... | 378,000 | 43 |
| All-day efficiency ..... | 98.6% | |

The step-down transformers are placed on the first floor of the substation. There are at present eight of these, each of 1500 kw. capacity at 35°C. temperature rise. All are made with a ratio of 54,000 volts, 3-phase to 15,000, and 2500 Scott-connected 2-phase, making four banks of transformers. The low-tension coils are connected in series for 15,000 and in multiple for 2500 volts, two banks being used on each voltage. The step-down transformer loss, computed in the same way as that of the step-up transformers, was as follows:

| | Kw.-hr. | Av. kw. |
|---|---|---|
| Core loss ..... | 692,000 | 79 |
| Copper loss ..... | 217,500 | 25 |
| Total loss ..... | 909,500 | 104 |
| All-day efficiency ..... | 96.6% | |

The sum of the losses in line and transformers was checked against the difference in the watt-hour meter readings on the low-tension side of the transformers at each end of the line, and was about 5% lower. This may not have been due to error, but may be largely due to corona loss or other line leakage. No measurements have as yet been made to determine this point.

The main substation contains the step-down transformers, a distributing switchboard of the remote control type, and the necessary switching and control apparatus for the distributing feeders. The switchboard carries a complete set of curve-tracing meters for the high-tension lines, indicating ammeters and wattmeters, and watt-hour meters for the transformers, and indicating ammeters, recording volt-meters, and watt-hour meters for the feeders. Loss in meters and their instrument transformers was computed from tests made on each type of meter and transformer. Current used for station light, heat, and display lighting was metered.

| | Kw.-hr. | Av. kw. |
|---|---|---|
| Loss in meters ..... | 29,000 | 3 |
| Power for station light..... | 317,400 | 37 |
| Total loss ..... | 346,400 | 40 |
| All-day efficiency ..... | 98.7% | |

A motor-generator set consisting of a 750-hp. 2-phase synchronous motor, direct-connected to two 250-kw. 250-volt direct-current compound-wound generators, is used on a 3-wire 500 and 250-volt system for operating elevators and other motors. The maximum load on this machine at the present time on the direct-current side is 300 kw., and the average load for 1911 was 30.2 kw. The surplus kilovolt-ampere capacity of the motor is utilized in regulating the voltage of the main system by varying the power factor by means of a Tirrill regulator controlling the field of the motor. There are at present 71 services connected on this system with a connected load of 772½ hp. The main feeder is 750,000-cir. mil cable with a 400,000-cir. mil neutral, and the branches usually No. 4/0 with No. 2/0 neutral. In all, 27 miles (43.4 km.) of wire is used on this system. The total loss in the direct-current feeders and the motor-generator was obtained from the difference in the motor watt-hour meters and the customers' meters. From recording volt-meter charts taken at various distributing points and at the substation and from computations, using the load data and line resistance, the line loss

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is placed at 5%. The details of losses and efficiencies follow:

| | Efficiency, 1911 | Loss, kw.-hr.. | Av. loss, kw... |
|---|---|---|---|
| Motor-generator ..... | 38.0 | 417,000 | 48 |
| Direct-current lines ..... | 95.0 | 12,800 | 1 |
| Customers' meters ..... | 98.8 | 3,000 | .. |
| Total direct-current system | 35.7 | 432,800 | 49 |

Current is distributed at 15,000 volts from the main substation to two smaller substations and to about twelve mills and factories which use large amounts of power. This system is 2-phase, with the centre point of each phase grounded. For mechanical reasons, No. 2 is the smallest wire used on the 15,000-volt lines. There are about 105 miles (169 km.) No. 2, nine miles (14.5 km.) of No. 1, and two and one-half miles (4.02 km.) of No. 0 wire. There are 30 transat substation and at the various receivers, and checked closely by calculation from the line constants and load data. The transformer losses on this system were computed from the load data on the station reports and the tests taken on each size and type of transformer under actual operating conditions.

Copper loss is small compared to core loss because the transformers were lightly loaded; an installation of 6250 kw. carried an average load of 1323 kw. The detail losses were:

| | Efficiency, 1911 | Loss, kw.-hr... | Av. loss, kw... |
|---|---|---|---|
| 15,000-volt lines ..... | 99.2 | 93,500 | 11 |
| 15,000-volt transformers ... | 93.2 | 775,100 | 88 |
| Core loss ..... | ... | 694,000 | 79 |
| Copper loss ..... | ... | 81,100 | 9 |
| Total for system..... | 92.5 | 868,600 | 99 |

Power is distributed from the substations

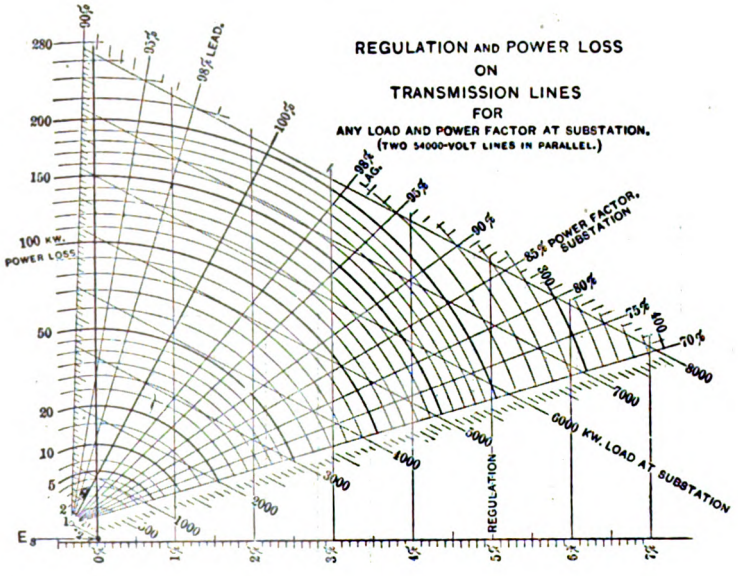


FIG 5.

formers connected, ranging in size from 750 to 50 kw., with a combined capacity of 6250 kilowatts.

Loss in the 1500-volt system was found by taking the difference in the meter readings by means of seventeen 2400-volt primary feeders. Of these, twelve are fed from the main substation at Seventh avenue and Yesler way, three from Fremont substation, and two from West Seattle substation. The

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more heavily loaded circuits were designed for 200 amperes and the lighter ones for 150 amperes. Number 4/0 wire was used at first, but the economic size for a 200-ampere feeder has been computed at 350,000-cir. mils, which size is now used on the heavier feeders. An area of 28 square miles (72.5 sq. km.) is served by this system extending seven miles (11.2 km.) south and six miles (9.6 km.) north of Yesler way. A distributing point is established at the approximate centre of distribution for each feeder, and the automatic regulators in this station are set to give the desired voltage at this point.

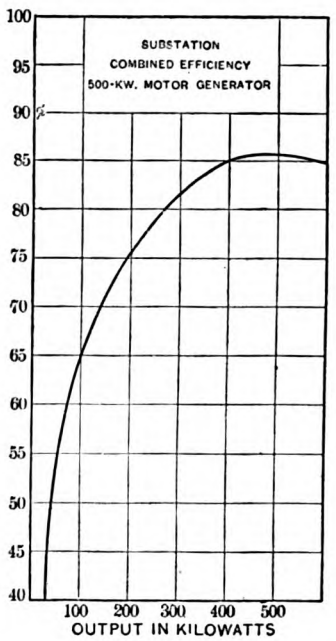


FIG. 6.

Connected to the 2400-volt feeders are 1082 distributing transformers, ranging in size from 2½ to 50 kw., and with an aggregate full-load capacity of 9268½ kw. They are connected to give a 240 to 120-volt 3-wire low-tension winding, with the neutral grounded. To aid regulation, a number of transformers of the same size and type are usually connected together on the low-tension side where conditions will permit. The secondary wire is generally No. 4 for the outside wires and No. 6 for the neutral, with No. 8 for the services. The maximum voltage drop from transformer to customer is

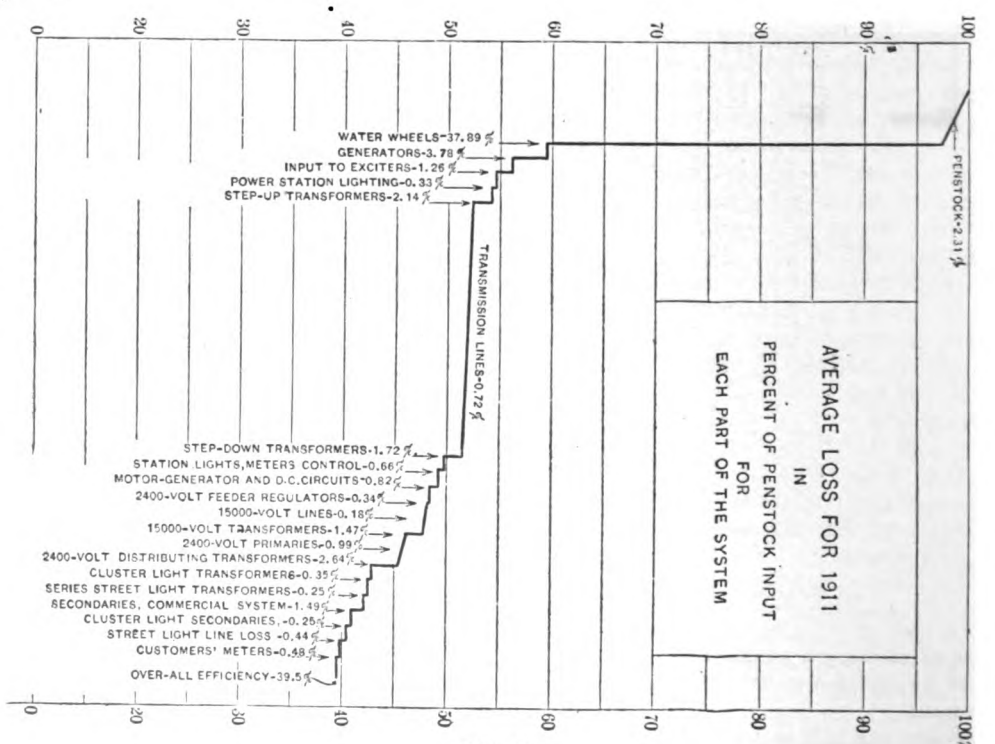


FIG. 7.

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OUTLINE OF LOSSES AND EFFICIENCIES FOR 1911, SEATTLE MUNICIPAL LIGHT AND POWER PLANT.

| | Per cent all-day efficiency | Total 1911 input, kw-hr. | Average 1911 input, kw. | Total 1911 loss, kw-hr. | Average 1911 loss, kw. | Per cent loss | Per cent of penstock input | Per cent of total loss |
|---|---|---|---|---|---|---|---|---|
| GENERATING SYSTEM | 54.4 | 52,619,000 | 6009 | 23,990,300 | 2739 | 45.6 | 45.6 | 75.3 |
| Penstocks | 97.7 | 52,639,000 | 6009 | 1,214,900 | 139 | 2.3 | 2.3 | 3.8 |
| Generating station | 55.7 | 51,424,100 | 5870 | 22,775,400 | 2600 | 44.3 | 43.2 | 71.5 |
| Water wheels | 60.7 | 50,758,900 | 5795 | 19,944,400 | 2277 | 39.3 | 37.9 | 62.6 |
| Generators | 93.5 | 30,814,500 | 3518 | 1,990,800 | 227 | 6.5 | 3.8 | 6.2 |
| Exciters | .... | 665,200 | 76 | 665,200 | 76 | .... | 1.3 | 2.1 |
| Station lights and control | .... | 175,000 | 20 | 175,000 | 20 | .... | 0.3 | 0.5 |
| TRANSMISSION SYSTEM | 91.6 | 28,648,700 | 3270 | 2,413,500 | 276 | 8.4 | 4.6 | 7.6 |
| Step up transformers | 96.1 | 28,648,700 | 3270 | 1,126,000 | 129 | 3.9 | 2.1 | 3.5 |
| Transmission lines | 98.6 | 27,522,700 | 3141 | 378,000 | 43 | 1.4 | 0.7 | 1.2 |
| Step-down transformers | 96.6 | 27,144,700 | 3098 | 909,500 | 104 | 3.4 | 1.7 | 2.9 |
| DISTRIBUTING SYSTEM | 79.2 | 26,235,200 | 2994 | 5,448,700 | 622 | 20.8 | 10.3 | 17.1 |
| City substation | 98.7 | 26,235,200 | 2994 | 346,400 | 40 | 1.3 | 0.7 | 1.1 |
| S. Lights and control | .... | 317,400 | 37 | 317,400 | 37 | 1.2 | 0.6 | 1.0 |
| Switchboard meters | .... | .... | .... | 29,000 | 3 | .... | 0.1 | 0.1 |
| 15,000-volt system | 92.5 | 11,587,000 | 1323 | 868,600 | 99 | 7.5 | 1.6 | 2.7 |
| 15,000-volt lines | 99.2 | 11,587,000 | 1323 | 93,500 | 11 | 0.8 | 0.2 | 0.3 |
| 15,000-volt transformers | 93.2 | 11,493,500 | 1312 | 775,100 | 88 | 6.8 | 1.5 | 2.4 |
| Series street lights | 86.3 | 2,672,800 | 305 | 367,200 | 42 | 13.7 | 0.7 | 1.2 |
| Transformers | 95.0 | 2,672,800 | 305 | 133,700 | 15 | 5.0 | 0.3 | 0.4 |
| Series circuits | 90.8 | 2,539,100 | 290 | 233,500 | 27 | 9.2 | 0.4 | 0.7 |
| Cluster street lights | 79.1 | 1,486,000 | 170 | 310,000 | 35 | 20.9 | 0.6 | 1.0 |
| Cluster transformers | 87.8 | 1,486,000 | 170 | 181,000 | 21 | 12.2 | 0.3 | 0.6 |
| Underground cables | 90.1 | 1,305,000 | 149 | 129,000 | 15 | 9.9 | 0.2 | 0.4 |
| 2400-volt commercial system | 76.2 | 13,178,400 | 1612 | 3,123,700 | 357 | 23.8 | 5.9 | 9.8 |
| Feeder regulators | 98.6 | 13,178,400 | 1612 | 178,500 | 20 | 1.4 | 0.3 | 0.6 |
| Primary feeders | 96.0 | 12,999,900 | 1592 | 521,600 | 60 | 4.0 | 1.0 | 1.6 |
| Transformers | 88.8 | 12,478,300 | 1532 | 1,391,000 | 159 | 11.2 | 2.6 | 4.4 |
| Secondaries | 92.9 | 11,087,300 | 1373 | 782,600 | 89 | 7.1 | 1.5 | 2.5 |
| Customers' meters | 97.6 | 10,304,700 | 1284 | 250,000 | 29 | 2.4 | 0.5 | 0.8 |
| Direct-current system | 35.7 | 673,200 | 77 | 432,800 | 49 | 64.2 | 0.8 | 1.4 |
| Motor-generator | 38.0 | 673,200 | 77 | 417,000 | 48 | 62.0 | 0.8 | 1.3 |
| D-C. circuits | 95.0 | 256,200 | 29 | 12,800 | 1 | 5.0 | .... | .... |
| Customers' meters | 98.8 | 243,400 | 28 | 3,000 | .... | 1.2 | .... | .... |

SUMMARY: Total power-loss.....31,852,500 kw-hr. Average 3,636 kw.
Total power delivered to customers.....17,304,900 " 1,975 "
Total power delivered to street lamps.....3,481,600 " 398 "
Total delivered power.....20,786,500 " 2,373 "
Over-all efficiency, 39.5 per cent.
[1 kw-hr. at the customers' premises requires 1,364 gallons (5,163 liters) of water from Cedar Lake at average head of 590 feet (179.8m.)]

kept within 2 volts whenever possible, since there is no way of regulating for voltage between these points. The pressure at the service is kept as near 120 volts as possible. Although standard 2200 to 110-volt transformers are used, the pressure has been raised to 2400 volts, and it is planned to raise it still further to 2500 volts. This gives about 25% higher core loss, but lowers the copper loss in both transformers and feeders about 29%, and in addition gives nearly 14% better regulation. The 2400-

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volt system used 545.4 miles (877.7 km.) of high-tension wire, ranging in size from No. 6 to 350,000 cir. mil, and 1137.7 miles (1830.9 km.) of low-tension wire, varying from No. 6 to No. 4/0.

Losses in the feeder regulators were computed from tests made on each type used, in conjunction with load data from the station reports. Losses in distributing transformers were computed in the same way, using also recording ammeter charts taken at distributing points. Losses in the high-tension line were computed from the load data and line resistances of each feeder, and checked by recording voltmeter charts taken at the station and at each distributing point. Loss in low-tension line was estimated from line resistance and load data, and checked by recording voltmeter at the customers' services.

A check on the various distributing losses is furnished by the difference in the power metered to the customer and that delivered to the distributing system. This amount proved to be slightly greater than the sum of the losses as computed, and the difference was added to the loss in low tension system, since that loss was most difficult to determine with accuracy. There is also probably a small amount of stolen current included in the low-tension loss. The details of losses on the 2400-volt commercial system follow:

| | Efficiency, 1911 | Loss, kw.-hr.... | Av. loss, kw.... |
|---|---|---|---|
| Feeder regulators ..... | 98.6 | 178,500 | 20 |
| Primary feeders ..... | 96.0 | 521,600 | 60 |
| Distributing transformers ..... | 88.8 | 1,391,000 | 159 |
| Core loss ..... | ... | 960,000 | 110 |
| Copper loss ..... | ... | 431,000 | 49 |
| Secondaries ..... | 92.9 | 782,600 | 89 |
| Customers' meters .... | 97.6 | 250,000 | 29 |
| Total for system..... | 76.2 | 3,123,700 | 357 |

The cluster-light system comprises 1631 poles, lighting 25 miles (40.2 km.) of street and carrying 6851 lamps of a total of 335,700 watts. This system is supplied from 720 kw. in transformers using 23 miles (37 km.) of primary wire carrying 2400 volts and 98.4 miles (158.3 km.) of secondary wire in a 240 and 120-volt 3-wire system. The voltage is changed from 120 volts to 8 volts in the base of the pole, and 8-volt multiple lamps are used. Losses on this system were computed in a similar manner to those on the other distributing systems. They lack the check of integrating meters at the lamp, but were easier to compute on account of the constancy of the load. The transformer losses contain those from the pole-base transformers, which are 250-watt, 8-volt transformers.

| | Efficiency, 1911. | Loss, kw.-hr.... | Av. loss, kw.... |
|---|---|---|---|
| Cluster-light primaries ... | 97.0 | 42,500 | 5 |
| Cluster-light secondaries.. | 93.0 | 86,500 | 10 |
| Cluster-light transformers. | 87.8 | 181,000 | 21 |
| Core loss ..... | ... | 117,500 | 13 |
| Copper loss ..... | ... | 63,500 | 7 |
| Total for system..... | 79.1 | 310,000 | 35 |

The series street-light system comprises 683 miles (1099 km.) of No. 6 wire divided into 29 circuits, lighting 601 miles (967.2 km.) of street. The circuits are connected two in series to 100-light air-cooled constant-current transformers. The voltage on the circuits varies with the number and kind of lamps from 2500 volts to 5000 volts. Altogether there are 692 6.6-ampere arc lamps, 5315 40-c.p. tungsten lamps, and 199 300-c.p. tungsten lamps. Losses were computed in a similar manner to those on the cluster-light system, and were as follows:

| | Efficiency, 1911 | Loss, kw.-hr.... | Av. loss, kw.... |
|---|---|---|---|
| Series lines ..... | 90.8 | 233,500 | 27 |
| Constant current transformers ..... | 95.0 | 133,700 | 15 |
| Core loss ..... | ... | 63,900 | 7 |
| Copper loss ..... | ... | 69,800 | 8 |
| Total for system..... | 86.3 | 367,200 | 42 |

The table, Fig. 8, shows the losses and efficiencies for each part of the system, and the accompanying diagram shows each loss expressed in percentage of penstock input.

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# Company Reports

*Coast Counties Light & Power Co.'s* statement for August and eight months shows continued improvement in surplus, earnings keeping well ahead of increased fixed charges occasioned by additions to plant. Surplus for August increased 9.41% and for eight months 15.21%. The company reports as follows:

| Month ended Aug. 31— | 1912. | Increase. |
|---|---|---|
| Gross earnings | $31,893.40 | $3,155.09 |
| Operating, taxes, and general expense | 16,276.36 | 1,300.16 |
| Earnings from operation | $15,617.04 | $1,854.93 |
| Net profit from Union Traction Co. | 6,163.83 | *500.62 |
| Income for bond interest | $21,780.87 | $1,354.31 |
| Bond interest | 6,046.66 | ..... |
| Surplus | $15,734.21 | $1,354.31 |
| Eight months ended Aug. 31— | | |
| Gross earnings | $193,994.58 | $20,801.19 |
| Operating, taxes, and general expense | 92,215.80 | 11,953.30 |
| Earnings from operation | $101,778.78 | $8,847.89 |
| Net profit from Union Traction Co. | 12,129.63 | 2,804.16 |
| Income for bond interest | $113,908.41 | $11,652.05 |
| Bond interest | 48,373.36 | 3,000.04 |
| Surplus | $65,535.05 | $8,652.01 |

*Decrease.

In March 1912 the Coast Counties Light & Power Co. was acquired by the Coast Counties Gas & Electric Co., subject to outstanding bonds, the system now being operated by the last-named corporation, which also controls, through stock ownership, the Union Traction Company.

*San Joaquin Light & Power Corporation* August statement shows that surplus applicable to dividends increased over August 1911 202.31%, while the increase in the same item for the eight months was 17.60%. This company has been bearing heavy interest charges for plant construction that has only recently begun to reflect itself in the earnings. On the present operating basis the surplus, after interest for the year, should show an increase of at least 25% over 1911. The company reports as follows:

| Month ended Aug. 31— | 1912. | Increase. |
|---|---|---|
| Gross income | $107,772.61 | $ 26,967.12 |
| Op. expenses | 43,124.30 | 1,585.05 |
| Net income | $ 64,648.31 | $ 25,382.07 |
| Interest | 31,016.71 | 2,875.19 |
| Balance | $ 33,631.60 | $22,506.88 |
| Eight months ended Aug. 31— | | |
| Gross income | $850,961.50 | $154,336.17 |
| Op. expenses | 353,182.55 | 42,464.72 |
| Net income | $497,778.95 | $111,871.45 |
| Interest | 248,855.71 | 74,604.08 |
| Balance | $248,923.24 | $ 37,267.37 |

*United Railroads of San Francisco* statement for the six months ended June 30 shows a greatly increased volume of business handled at a lower cost. In other words, while gross earnings increased, operating expenses fell off, and net increased $46,000 more than gross. Following is the statement:

| | Gr. Earns. | Inc. | Net Earns. | Inc. |
|---|---|---|---|---|
| Jan. | $671,393 | $36,081 | $310,380 | $31,197 |
| Feb. | 649,279 | 71,697 | 306,291 | 72,484 |
| March | 691,754 | 34,578 | 337,967 | 44,188 |
| April | 683,667 | 30,801 | 328,860 | 39,024 |
| May | 720,462 | 52,732 | 362,593 | 64,321 |
| June | 691,556 | 64,087 | 346,433 | 84,495 |
| Six mo. | $4,108,111 | $289,976 | $1,992,524 | $335,709 |

Date on which the United Railways Investment Co. contemplates resumption of dividends on its preferred stock has not been announced. The last dividend on this issue was 2½% (in scrip) paid on January 2, 1907. Therefore, the unpaid accumulated dividends to July 1, 1912, amounted to 27½%. The Investment company owns practically all the stock of the United Railroads, and also owns all of the stock of the Railroads & Power Development Co., which in turn controls the Sierra & San Francisco Power Co. and the San Francisco Electric Railways Co. The company also owns a

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controlling interest in the Philadelphia company.

Earnings of the various properties just mentioned are showing up well in comparison with a year ago. For the fiscal year ended December 31 last the Investment company earned a surplus over interest charges equal to 5.25% on the $16,000,000 outstanding preferred stock, as compared with 4.79% in the previous year, 3.20% in 1909, and 1.77% in 1908. This year it is estimated that the company will show earnings equal to more on the stock than the percentage above for 1911.

The following table shows the Investment company's total income balance for dividends and percentage earned on the preferred stock for each of the last four calendar years:

| | Total Income. | Balance for Divs. | Equals on Pfd. Stock. |
|---|---|---|---|
| 1911 | $2,136,535 | $840,827 | 5.15 |
| 1910 | 2,109,561 | 776,468 | 4.79 |
| 1909 | 1,830,685 | 512,350 | 3.20 |
| 1908 | 1,558,789 | 265,045 | 1.77 |

At the close of the last fiscal period the company had a profit and loss surplus of a trifle more than $3,100,000, as compared with $2,368,779 on December 31, 1910.

---

*The Atchison, Topeka & Santa Fé Railway Co.* reports for August:

| | 1912. | Changes. |
|---|---|---|
| Gross op. revenue | $9,630,813 | Inc. $ 763,172 |
| Op. expenses | 6,268,803 | Inc. 244,257 |
| Net op. revenue | $3,362,009 | Inc. $ 518,915 |
| Taxes | 382,456 | Inc. 51,758 |
| Op. income | $2,979,553 | Inc. $ 467,156 |
| From July 1st— | | |
| Gross op. revenue | $18,590,782 | Inc. $1,701,497 |
| Op. expenses | 12,515,701 | Inc. 673,637 |
| Net op. revenue | $ 6,075,080 | Inc. $1,027,860 |
| Taxes | 763,348 | Inc. 110,070 |
| Op. income | $ 5,311,732 | Inc. $ 917,789 |

---

*The Mount Whitney Power & Electric Co.* earned 2½ times its fixed charges for the year ended August 31, 1912, according to its official statement made public yesterday. Following is the statement for August and for the twelve months ended August 31:

FOR AUGUST, 1912

| | |
|---|---|
| Gross revenue | $39,762 |
| Operating expense | 22,315 |
| Net income | 17,447 |

FOR TWELVE MONTHS

| | | | |
|---|---|---|---|
| Gross revenue | $429,638 | $413,628 | Inc. $16,010 |
| Operating exp. | 202,974 | 180,998 | Inc. 21,976 |
| Net income | 226,664 | 232,630 | Dec. 5,966 |

During the past year the company has made heavy capital expenditures that are only just beginning to reflect in the earnings, and the next few months should show a decided improvement. There has been devoted to new construction during the past year $420,857.71.

---

*The Pacific Power & Light Co.* reports for the year ended June 30 last, as follows:

| | |
|---|---|
| Gross earnings | $1,207,523 |
| Operating expenses and taxes | 645,412 |
| Net earnings | $ 562,111 |
| Interest on bonds | 281,621 |
| Other interest | 36,422 |
| Net income | $ 244,068 |
| Dividends | 208,095 |
| Surplus | $ 35,973 |
| Previous surplus | 91,327 |
| Total profit and loss surplus | $ 127,300 |

---

*The Northern California Power Co., Con.*, reports for September as follows:

| | |
|---|---|
| Gross earnings | $67,809.69 |
| Operating and general expenses | 19,353.88 |
| Net earnings | $48,455.81 |
| Maintenance and depreciation reserve | 9,877.28 |
| | $38,578.53 |
| Interest on bonds and debentures | 29,498.90 |
| Available surplus and dividends. | $9,079.63 |

Operating and general expenses carry an amount of $1812.42 over normal to adjust previous estimates for insurance and taxes.

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*California Petroleum Corporation* subsidiary companies, including the American Pe-

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troleum Co. and the American Oil Fields Co., report for the year ended December 31, 1911, and the seven months ended July 31 last, as follows:

| | 7 months. July 31, '12. | Year. Dec. 31, '11. |
|---|---|---|
| Oil sales | $1,408,672 | $2,307,660 |
| Inc. in inventories, etc. | 213,974 | 231,159 |
| Total income | $1,622,646 | $2,538,819 |
| Expenses— | | |
| Operating | $219,438 | $335,430 |
| Taxes and royalties | 41,309 | 61,477 |
| Bond sinking fund | 91,297 | 156,510 |
| Total deductions | $352,044 | $553,418 |
| Net profits | $1,270,602 | $1,985,402 |
| Interest charges— | | |
| Bond interest | $125,378 | $173,084 |
| Interest on loans | 25,924 | 70,006 |
| Total interest | $151,302 | $243,150 |
| Surplus | $1,119,300 | $1,742,150 |

The balance sheet of the California Petroleum Corporation as of September 28 last, follows:

ASSETS

| | |
|---|---|
| Investments— | |
| American Petroleum Co., pfd. | $1,676,720 |
| American Petroleum Co., common | 9,974,720 |
| American Oil Fields Co., common. | 14,643,040 |
| Value of above stocks based on appraisal of properties and balance sheets of the companies as of July 13, 1912 | $23,863,999 |
| Cash | 3,400,150 |
| Total | $27,264,155 |

LIABILITIES

| | |
|---|---|
| Preferred stock— | |
| Authorized | $17,500,000 |
| Issued | 11,997,024 |
| Common stock— | |
| Authorized | $17,500,000 |
| Issued | 13,513,081 |
| Surplus | 1,754,050 |
| Total | $27,264,155 |

A circular has been issued showing assets and earnings of the *California Petroleum Co.*, the merger of Canfield-Doheny properties. The statement follows: The companies acquired by the California Petroleum corporation own 3786 acres classed as proved oil lands, and 15,000 acres favorably situated in producing oilfields, but upon which no estimate is made as to their oil contents and values. The proved lands are estimated to contain 295,000,000 bbl. of oil, and the appraised value of the property is placed by the company's engineer at upward of $32,000,000. Oil production in 1911 amounted to 5,432,196 bbl., and the output now is nearly 500,000 bbl. per month, or at the rate of 6,000,000 bbl. per year. Consolidated earnings of the companies for the year ended December 31, before providing for depreciation, were $1,943,047, and earnings for the seven months ended July 31, 1912, totaled $1,236,430. Earnings for next year are estimated at $2,300,000. The common stock has been placed in a five-year voting trust, and it is stated by the officers of the corporation that after providing out of earnings for proper development expenses the company will be in a position to start dividends on the common stock at the rate of 4% per year.

*The Pacific Gas & Electric Co.* reports for eight months ended August 31:

| | | |
|---|---|---|
| Gross earnings | $9,694,841 | |
| Exp., including taxes and reserves | 5,464,755 | |
| Net earnings | | $4,230,086 |
| Bond and other interest | | 2,319,118 |
| Balance | | $1,910,968 |
| Bond discount and exp. | $ 72,572 | |
| Pfd. stock dividends | 400,000 | |
| Com. stock dividends | 730,092 | |
| | | 1,202,664 |
| Surp. for depreciation and other purposes | | $ 708,304 |

Net earnings for August 1912 compared with August 1911 increased $41,431.

At the close of August the company was serving 305,811 consumers, an increase of 18,705 compared with Dec. 31, 1911.

*The Petaluma & Santa Rosa Railway Co.* reports for the twelve months ended July 31: Gross earnings, $305,027; operating expenses, $210,041; net earnings, $95,986; interest, $49,700; surplus, $46,286.

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# Engineering Bonds

*Tax exempt in California.
†Legal investment for savings banks in California.
‡Available as security for deposit of state, county, and municipal funds and postal savings deposits.

*Pacific Gas & Electric Co. has issued $5,000,000 general and refunding mortgage 5% gold bonds with the approval of the Railroad Commission of California. The bonds are dated December 1, 1911, due January 1, 1942, and are in denominations of $1000, with interest payable January 1 and July 1. The proceeds of this issue will be applied to various additions and extensions of the company's system, including a hydro-electric development on the Yuba and Bear rivers which will have an initial generating capacity of 53,000 hp. The completion of this development will make the company independent of outside sources of power supply, and thus effect a material saving compared with the present cost of current purchased from outside sources, and will also provide a surplus of approximately 26,000 hp. available for future sale. One hundred and sixty-two communities are supplied with electricity and power, 41 with gas for heating and lighting, 8 with water for domestic purposes, and the city of Sacramento with street railway service. The growth in the total number of consumers during the last five years has shown a large and steady increase, the number on June 30, 1912, being: gas, 185,028; electricity, 106,817; water, 7505; making a grand total of 299,350. The electric generating plants, operated by both water and steam power, including distribution system, are all linked together, insuring flexibility and continuity of service. The following details regarding the company's physical properties indicate the extent of their development:

| | |
|---|---|
| Electric department: | |
| Plants, number | 16 |
| Capacity (water power), hp | 92,973 |
| Capacity (steam), hp | 99,600 |
| Total generating capacity, hp | 192,573 |
| Water-powers under development, hp. | 100,000 |
| Lines: | |
| Overhead, miles | 3,895 |
| Underground, miles | 69 |
| Sub-stations, number | 117 |
| Sub-stations (capacity), hp | 282,310 |
| Street railway department: | |
| Track, miles | 38.98 |
| Cars, number | 62 |
| Gas department: | |
| Plants, number | 16 |
| Capacity per day, cu. ft. | 42,100,000 |
| Annual sales, cu. ft. | 6,187,583,000 |
| Mains, miles | 2,159 |
| Water department: | |
| Reservoirs, number | 49 |
| Capacity, gallons | 18,543,000,000 |
| Irrigation canals, pipe-lines, miles | 529 |
| Mains, miles | 73 |

Capitalization

| | |
|---|---|
| Common stock outstanding with public (dividends paid at rate of 5% per annum) | $31,998,750 |
| Preferred stock outstanding with public (6% cumulative) | 10,000,000 |
| General and refunding mortgage 5s, including present issue | 25,000,000 |
| Underlying divisional bonds for the retirement of which a like amount of general and refunding 5s are reserved, including $257,000 in treasury | 51,443,000* |

*The aggregate amount of the present underlying issues can never be increased. Seventy-five per cent of the company's steam plants is of modern turbine construction.

Earnings

| | 8 mos. to Aug. 31, 1912. | 1911. | 1910. | 1909. |
|---|---|---|---|---|
| Gross earnings | $9,694,841 | $14,604,609 | $14,044,596 | $13,491,288 |
| Op. exp. maintenance and taxes | 5,464,755 | 8,214,072 | 7,921,341 | 7,531,576 |
| Net earnings | $4,230,086 | $ 6,390,537 | $ 6,123,255 | $ 5,959,712 |
| Bond interest paid | 2,319,118 | 3,254,133 | 3,006,256 | 2,988,522 |
| Balance | $1,910,968 | $ 3,136,404 | $ 3,116,999 | $ 2,971,199 |

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THE OAKLAND RAILWAYS have issued $2,500,000 of 6% ten-month notes in denominations of $25,000. This company is a part of the United Properties Co., controlled by the Smith-Tevis-Hanford interests and already has outstanding $2,500,000 6% four-year notes, dated September 6, 1911, and due September 1, 1915, which have been called for payment on September 1, 1912. The collateral security consists of $1,849,000 Oakland Traction Co., general construction 5% bonds, and $1,413,000 Key Route construction 5% bonds, $129,000 East Shore & Suburban first-mortgage bonds, 63% of the stock of the Oakland Traction Co., 60% of the stock of the Key Route, and all of the stock of the Sacramento Short Line, San Jose Short Line, California Railway, and Pacific Terminal Co. The notes have also been indorsed by the individual companies. The total collateral security amounts to $3,256,000 in bonds, $18,521,200 in stock, the notes also being guaranteed by the indorsement of F. M. Smith. It is assumed that these notes have been issued for the purpose of raising funds to meet the payment of the $2,500,000 four-year notes called for redemption. In case a refunding bond issue is created during the life of the notes, it is provided that the first proceeds shall be applied to the redemption of the ten-month notes.

---

The RIVERSIDE WATER CO., contingent upon the approval of the State Railroad Commission, has decided to issue $600,000 in 6% one-year notes due October 1, 1913. These notes are secured by a deposit of $750,000 in 6% first mortgage bonds on all the company's property estimated to be worth $2,370,418. As negotiations are pending between the water company and the city of Riverside for the sale of that portion of the plant within the limits of the city, it is necessary for the company to refund an existing issue of bonds at this time. As the notes are also a lien upon the irrigation system owned by the company, it is considered that the margin of safety behind the notes is about 400%. The earnings for both systems during 1911 were $143,550 against a charge of $36,000.

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The SEABOARD OIL & TRANSIT CO. had a meeting of stockholders and authorized a bond issue of $2,500,000. A statement presented at the meeting shows the company's assets to be $1,708,446.80, and liabilities $348,918.59. The proceeds from the sale of bonds are to be used to pay off outstanding indebtedness and $1,000,000 is to be reserved for a European syndicate which is negotiating for the purchase. These funds will be used for future development of the company's property in Mexico.

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THE RAILROAD COMMISSION has authorized the Central California Gas Co. to issue additional bonds to the amount of $219,000 and additional preferred stock to the amount of $136,200. The company operates in Tulare county, and will use the proceeds from the sale of the securities to purchase the Consolidated Heat, Light & Power Co. of Visalia and Tulare. They will also construct a transmission line from Exeter and Visalia and will install additions to the gas plant in Visalia with distributing systems in Visalia and Tulare. A gas-holder will be constructed in Porterville, and transmission lines will be erected between Porterville and Lindsay, and Lindsay and Exeter. Distribution systems are to be built in Lindsay and Exeter.

---

THE NORTHERN CALIFORNIA POWER CO., CONSOLIDATED, has received permission from the Railroad Commission to issue $500,000 of its 6% debenture notes. The notes are in denominations of $1000, dated July 1, 1912, payable July 1, 1917, and are callable upon any interest date prior to maturity at a premium of one-half of 1% for each remaining year.

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STATE RAILROAD COMMISSION is conducting a hearing regarding the application of the Northern Electric Co. for the issuance of $8,500,000 in bonds, the proceeds of which it is proposed to utilize for taking over the Vallejo & Northern railroad and the completion of the extension from Vallejo to Sacramento. When the Northern Electric formally secures this road it will have gained entrance to San Francisco, using a ferry service between here and Vallejo. The present value of the Northern Electric is said to have been in the neighborhood of $7,500,000 in June of this year, but is now $10,000,000. It is proposed to use $6,500,000 of the proposed bond proceeds for construction work in extending the Vallejo & Northern to Sacramento.

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# Book Reviews

THE DESIGN OF STEEL MILL BUILDINGS. By Milo S. Ketchum. McGraw-Hill Book Co., New York. 478 pp., index. For sale by the *Mining and Scientific Press*, San Francisco. Price $4.

This book needs no introduction to engineers, as Mr. Ketchum's works covering the various applications of steel structures have been recognized as a standard for many years. The first edition was issued in 1903, and was so well received that a second edition was published in 1906. This is the third edition, which has been amplified and enlarged in order to bring the text up to improvements in practice that have taken place during the past six years. The chapters on 'Stresses in Framed Structures' and 'Stresses in Bridge Trusses' have been rewritten and enlarged. Specifications for steel-frame buildings have been revised and rewritten. Many additions have been made, including two problems in graphic statics, and appendix III, covering structural drawings, estimates, and designs. The latter contains 78 pages, 30 tables, and 24 illustrations, which furnish much data not readily available. While the title would indicate that steel mill buildings monopolized the text, the greater part of the data given would apply to steel building design in general.

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A TEXT-BOOK OF PHYSICS. By A. Wilmer Duff and others. P. Blakeston's Son & Co., Philadelphia. 686 pp., index. For sale by the *Mining and Scientific Press*, San Francisco. Price $2.75.

This is the third edition of this book, the section devoted to 'Mechanics' having been prepared by A. Wilmer Duff; 'Wave Motion,' by E. Percival Lewis; 'Heat,' by Charles E. Mendenhall; 'Electricity and Magnetism,' by Albert P. Carman; 'Conductivity of Electricity through Gases and Radio-Activity,' by A. K. McClung; and 'Sound,' by William Hallock. The primary object in the preparation of this work was to provide a textbook for students that would present the laws of physics and the various phenomena pertaining thereto, clearly and concisely, in order that a thorough understanding of the fundamentals would be assured before proceeding with a study of their application. The various co-authors are all teachers of note, who have brought their experience to bear by the preparation of the text to suit the needs of students. While no essential feature has been overlooked in any of the sections into which the book is subdivided, there is an absence of the padding and verbosity that often characterize a work of this kind. It is a publication well worth while, not only for students in schools and colleges, but for older men engaged in engineering practice, who will appreciate the thoroughness and systematic grouping of the subject matter whenever there is occasion to indulge in a little 'brushing up.'

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ARTISTIC BRIDGE DESIGN. By Henry Gratton Tyrell. Myron C. Clark Publishing Co., Chicago. 290 pp.; index. For sale by the *Mining and Scientific Press*, San Francisco. Price $3.

Author's preface states that a lack of artistic treatment is the greatest fault of the American bridges, and, judging by the number of illustrations showing inexcusably ugly structures to be found in various parts of America, it would appear that the author has proved his case. There is a marked contrast between the generality of bridges to be found in the United States, particularly those that were constructed 15 or 20 years ago, and those to be found in various parts of Europe. There could be no greater evidence that in many ways Continental Europe is some hundreds of years ahead of us in civilization in an artistic sense than is shown by the combination of art and utility in the design of their bridges. Ugly structures are not only unnecessary, but stupid, and there is no doubt that American bridge designers, in an artistic sense, have been sadly remiss in the past. Many of the more recent structures, however, would indicate that an artistic awakening is taking place, and that bridge designers of today have arrived at a proper conception of the benefits derived from structures having a beautiful exterior. Bridge designers will find Mr. Tyrell's work very helpful. The question of design from an engineering standpoint is not discussed, but the entire text is given over to the artistic and suggestions for its attainment. The book is profusely illustrated throughout, giving many examples of the best and the worst construction in an artistic sense.

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# Engineering News

## Power, Gas, and Electricity

*San Francisco.*—The Coast Counties Light & Power Co. reports for the month of September as follows:

| | 1911. | 1912. |
|---|---|---|
| Gross earnings | $26,488 | $30,959 |
| Operating expenses | 15,129 | 17,600 |
| Net earnings | 11,359 | 13,359 |
| Other income | 1,308 | 1,370 |
| Total income | 12,667 | 14,729 |
| Interest | 6,621 | 6,046 |
| Surplus | 6,621 | 8,683 |

The Vallejo & Northern Railroad Co. has filed application with the Railroad Commission for permission to cross at grade over Second, Third, Fourth, Fifth, Sixth, and Seventh streets where they intersect M street in Sacramento. It has also asked for permission to cross the street railroad of the Pacific Gas & Electric Co. at the intersection of Third and Seventh streets with M street.

The Railroad Commission has granted permission to the Coast Valleys Gas & Electric Co. to take over the property of the King City Water, Light & Power Co.——L. W. Warmouth has applied to the Railroad Commission for permission to sell his telephone line, from Corning in Tehama county to Newville in Glenn county, to the Pacific Telephone & Telegraph Co.——The Railroad Commission has rendered a decision providing for a reduction in the wholesale rate for electric power charged by the Snow Mountain Water & Power Co. to the Napa Valley Electric Co. The reduction is from an average of 1.81c. per kilowatt-hour to a rate varying from 1 to 1.25c. per kilowatt-hour.——The Railroad Commission has extended the time for the issuance of $500,000 in notes by the People's Water Co. based upon bonds as collateral security, from October 30, 1912, to January 28, 1913.——Stockholders of the Puget Sound Traction, Light & Power Co. have voted to authorize the issue of $1,136,400 of unissued preferred stock to be offered to the shareholders at par.——The Mountain Power Co. has applied to the Railroad Commission for a certificate of public convenience and necessity to construct an electric plant in Crescent City and to operate in Del Norte county.——A series of tests is to be conducted under the supervision of the State Railroad Commission to determine the effect of induction upon the lines of the Pacific Telephone & Telegraph Co. on account of their proximity to the high-tension power wires of the Great Western Power Co., the Sierra & San Francisco, and Coast Counties Gas & Electric companies.——The Central California Traction Co. has issued the following report for the year ended June 30, 1912:

| | | |
|---|---|---|
| Operating revenue | | $302,569.16 |
| Operating expenses | | 214,446.62 |
| Net revenue | | $ 88,122.54 |
| Expenditures: | | |
| Taxes | $ 4,888.56 | |
| Interest | 75,000.00 | |
| | | 79,888.56 |
| Surplus | | $ 8,333.98 |
| Surplus June 30, 1911 | | 5,978.18 |
| Total surplus | | $ 14,212.16 |

The Nevada-California Power Co. has in view several extensions of power lines, according to the Inyo *Register.* Survey has been completed and construction contract let to M. A. Stampher & Co. of Los Angeles for the extension to Big Pine through the Sunland district. The route affords a favorable opportunity for the installation of pumping plants for irrigating of high lands. B. E. Sherwin is engineer in charge of the survey for the transmission line from Lone Pine to Keeler which will be installed in order to tap the mining and industrial fields in that district. It is proposed to run a transmission line to Laws, thence north to Chalfant, and then on as far as Benton. The company reports earnings as follows for August 1912:

| | 1912. | 1911. |
|---|---|---|
| August, gross | $ 75,336 | $ 63,894 |
| August, net | 63,211 | 51,252 |
| August, surplus | 50,657 | 37,022 |
| Eight months' gross | 556,458 | 504,927 |
| Eight months' net | 460,962 | 399,519 |
| Eight months' surplus | 346,960 | 285,079 |

The Southern Sierra Power Co. is proceeding with the construction of plant No. 6, situated near the old Standard flour-mill site near Bishop creek. The water will be piped from an intake at plant No. 5 and will have about 300-ft. fall. The new plant

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will include a 2000-kw. generator and the usual accessories.——The California-Oregon Power Co. has completed its transmission line in Klamath Falls, Oregon, and has made connection with the power lines in that city. The company has generating plants on the Rogue river at Prospect, Oregon, on the Klamath river and Klamath falls, and in the Klamath river canyon at Falls creek. A total of 110,000 hp. is available, and it is expected that contracts will be made for furnishing power for pumping water to lands that are too high to be irrigated from the Government canal. There are approximately 20,000 acres of such land in the immediate neighborhood. The company has also completed a transmission line into Butte valley, California, and will furnish power for industrial purposes in southern Oregon and northern California.

*Los Angeles.*—The Board of Public Utilities, as a result of an investigation recently conducted at Bakersfield, has suggested a rate of 60c. for natural gas, which is about to be piped from the Midway fields to Los Angeles.——The West Coast Gas, Light & Fuel Co. and the Home Gas & Electric Co. of Newport Beach have applied to the Railroad Commission for authority to consolidate under the name of the West Coast Gas Co. for the purpose of extension of operations in the towns of Downey, Norwalk, Artesia, Somerset, and Clear Water. A bond issue of $250,000 is proposed in order to supply funds for improvements and extensions.——The Pacific Light & Power Co. has finished surveys for the power-transmission line to be installed from the company's plant in Crane valley to Los Angeles. This line will run within five or six miles of Bakersfield, but it is not expected that the power will be extended in the oilfields, as that territory is already covered by the San Joaquin Light & Power Co. The Crane valley plant and transmission lines will cost approximately $6,000,000 when completed. The Stone & Webster Co. have the contract for the work.

*Oroville.*—A new power company has been formed consisting of J. G. Eby of Oakland, F. H. Whisner of San Francisco, and L. F. Breuner of Sacramento. Sixty thousand inches has been appropriated in Fall river near Oroville, and the company proposes to install a hydro-electric power-plant at a cost of $360,000. The water will be conducted through a tunnel and ditch, and will have a fall of 200 ft. at the power-site. A reservoir will be built between the walls of the Fall river canyon. Water will be impounded by a concrete dam. Construction work is to commence early next spring.

*Downieville (Sierra county).*—The Marysville & Nevada Power & Water Co., of which James O'Brien of Marysville is general manager, has advertised for bids for running a tunnel to divert water from the river at Goodyear bar for the purpose of generating electric power. A dam will be built in the spring, power-plant installed, and transmission lines constructed. Jason R. Meen, John E. Ebert, of Marysville, and James K. O'Brien are interested in this enterprise.

*Salt Lake City.*—The Utah Securities Co. has acquired the Telluride Power Co. and the Utah Power Co., which latter concern has also acquired the Knight Consolidated Power Co., the Davis & Webber Counties Canal Co., and a number of smaller companies operating electric light and power plants in Idaho, Colorado, and Utah. The Securities corporation has authorized an issue of $25,000,000 ten-year collateral trust notes and $27,500,000 in stock. It is stated that a syndicate has underwritten the securities, of which $9,000,000 has just been issued. Approximately 150,000 hp. in the aggregate will be brought under one control. S. Z. Mitchell is president; Charles Hayden, James Campbell, R. E. Breed, and James R. Nutt are directors.

*Wardner, Idaho.*—The Washington Water Power Co. has commenced construction of a high-potential line from its distributing station at Wardner to Pine Creek to furnish power to the Nabob mine.

*San Luis Potosi, Mexico.*—A concession for 99 years has been granted by the Mexican Government to J. D. Spillane, of this place, which permits taking 75,000 litres (litre = 1.05 quarts) of water per second from the Santa Maria and Gallinas reservoirs from the generation of electric power. Plans and specifications for the power-plant must be submitted on or before May 1914. Power available is said to amount to approximately 40,000 hp. The operating head will be 106 metres.

*Grants Pass, Oregon.*—The municipal power projects at Grants Pass for the development of water power on Grave creek is the subject of a report by Messrs. Hobson and

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Hall, engineers employed by the city for that purpose. The report is favorable to the project, and it is proposed that a dam, ditch, pipe-lines, irrigation canals, and power development be undertaken. The construction of a dam 175 ft. high will give a storage capacity of 40,000 acre-feet. The power-transmission line from the power site to the city will be approximately 17 miles in length. Approximately 5000 hp. will be developed. The estimated cost of the plant will include:

| | |
|---|---|
| Purchase of 600 acres of land in reservoir | $ 15,000 |
| 500,000 cu. yd. earth fill in dam | 100,000 |
| Outlet tunnel and gates | 18,000 |
| Permanent spillway | 12,000 |
| Clearing 600 acres in reservoir | 50,000 |
| 16 miles of canal from reservoir to power plant | 48,000 |
| 17 miles of pipe-line | 85,000 |
| Total | $328,000 |

In addition, road construction will cost $37,000, and the first unit in the power-plant, which will be approximately 1000 hp., together with 17 miles of transmission-line, will add $142,000, bringing the total cost to $507,000.

*Black Hills, South Dakota.*—South Dakota & Consolidated Power & Light Co. has concluded a deal for the purchase from the Dakota Power Co. of all of its surplus power, amounting at present to about 1000 kw. Thirty miles of high-tension transmission line will be immediately erected between Whitewood to the terminus at the Consolidated line and Black Hawk and end of the Dakota lines.

## Streets and Roads

*San Francisco.*—The California Highway Commission has commenced publication of a bimonthly bulletin devoted to the construction of the new state highway. This bulletin is, as stated in the foreword, a state document, its purpose being to present reviews of the work accomplished and forecasts of the plans proposed by the Commission. Copies will be mailed regularly, upon application, to those interested. The publication of this bulletin is an excellent plan and is a strong exemplification of the new order of things that lets the taxpayers know how their money is being expended, and should induce a proper appreciation of the splendid work that has been done. The bulletin contains a statement of the activities of the various counties in order to coöperate with the Commission; a specification of the minimum requirements for all new bridges, trestles, and culverts; the decision of the Attorney General in regard to route; and the complete statement of the result of the first year's activities of the engineering department and the financial statement from the State Treasurer showing the disposition of funds acquired by the sale of bonds.

*Sacramento.*—Contracts aggregating $167,032 for the construction of roads in three counties were awarded on October 22, as follows: In Santa Clara county, macadam base and asphalt surface, to the City Street & Improvement Co., $41,905. In Sonoma county, from Healdsburg to Santa Rosa, oiled concrete, to Richard Keating & Sons, San Francisco, $61,396. In Los Angeles county, the Calabasas road, oiled concrete, to Rogers Brothers Co., Los Angeles, $33,043. In Santa Clara county, oiled concrete, to A. Teichert & Son, Sacramento, $30,688.——Surveys have been ordered to be made in Santa Barbara county for the proposed state highway between Zaca station and Gaviota pass by way of Los Olivos, Santa Ynez Mission, and Alesal grade.——A survey has been ordered in Tulare county along a line substantially parallel to the Southern Pacific railroad.——Local capitalists have offered a loan of $15,000 to the state, thereby enabling work to be completed on the new state highway from Tallac to McKinneys; the $25,000 appropriation by the last legislature has been insufficient for the completion of the road.——The State Highway Commission will advertise for bids covering construction of the following sections of road for the state highway: San Luis Obispo county, from the city of San Luis Obispo to Santa Margarita, 6.4 miles, oiled concrete pavement, which is, in other words, oiled facing or surface on a concrete base. Stanislaus county, through the town of Ceres, 0.7 mile, oiled concrete pavement. Butte county, from Lindo channel, 1½ miles north of Chico, to the northern boundary of the county, 11.2 miles, oiled concrete pavement. Santa Clara county, Edenvale to Morgan Hill, 13 miles, oiled concrete pavement. San Diego county, Encinitas to Oceanside, 10.3 miles, oiled concrete pavement. Merced county, from the city of Merced to the southern boundary line of

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the county, 14.2 miles, oiled concrete pavement. San Mateo county, Redwood City to the southern boundary of the county, 3.3 miles, asphalt surface on a macadam base; at Burlingame, 0.2 mile, asphalt surface on a concrete base. Monterey county, 3.2 miles north of the Kings City bridge to Greenfield, 7.4 miles, oiled concrete. Mendocino county, from Ridgewood to Willetts, 6.9 miles, grading only.

*San Mateo.*—The advisory board on good roads has received a report from R. M. Morton, consulting engineer, covering road building to be carried out under the proposed $2,500,000 bond issue.

*Los Angeles.*—An estimate has been made by Homer Hamlin, city engineer, in which he shows that it will cost $133,000 for the improvements of Pacific avenue from the San Pedro and Willmington road to the intersection of Fourteenth and Beacon streets. Of this sum, $33,000 will have to be expended for grading the necessary storm-sewer construction, and the remainder for providing guttering, curbing, and constructing cement sidewalks. Of this amount, the city is to furnish $62,000, private property owners $38,000, and $33,000 by private property owners in the affected district.

## Railways

*San Francisco.*—The United Railways has applied to the Supervisors for a revokable permit to install a double-track railway on Bay street from Polk to the entrance of the Fort Mason Military Reservation. License has already been granted by the Secretary of War.

The Railroad Commission has issued an order calling upon the electric railroads of the state to furnish inventories and statements to enable the Commission to proceed with the appraisement of their properties. ——The Santa Fé railroad has purchased the old Adams Point Co.'s wharfage and dockage facilities on the Oakland waterfront, approximately $1.500,000 being involved in the deal. This project will enable the railroad company to carry practically all the freight now handled over its Twentieth and Adeline and Fortieth and San Pablo rail lines from Richmond by water, and it will greatly facilitate handling and transporting freight between its China basin docks and Oakland. ——The Southern Pacific Co. has applied to the Railroad Commission for permission to purchase a railroad franchise granted by the city of Richmond in Contra Costa county to H. C. Cutting.——The Northern Electric company has applied to the Railroad Commission for permission to issue $5,500,000 in bonds to provide funds for the purchase of the Vallejo & Northern and its subsidiaries, including the Suisun & Vacaville. It is considered that this indicates the intention of the Northern Electric to enter San Francisco by steamer from Vallejo within one year.——The Sacramento Valley Electric Railway Co. is making excellent progress in securing rights-of-way. The line down the west side of the Sacramento valley from Red Bluff to a point below Dixon is practically secured. Connection will be made at this latter point with the Oakland, Antioch & Eastern railway.——The State Harbor Commission will extend the belt railway across Sections 8a and 8b of the seawall through to the ferry. Plans and specifications for constructing a timber bulkhead wharf in front of the seawall at Section 8 have been approved. Plans and specifications have been adopted for seven piers ranging in width from 140 to 260 ft. and in length from 800 to 1060 ft. Work is to be commenced in two months. Five new piers are to be built, extending from the south of the new slips at the proposed extension to the southern end of the Ferry building. The following demands for construction work were approved and ordered paid: Grant Smith & Co., pier 26, $7764.75; Pacific Wakefield Co., piers 30 and 32, $21,959.57; Healy Tibbitts Construction Co., pier 17, $7902; San Francisco Bridge Co., pier 28, $7064.——The Western Pacific railroad is planning to change its present route to connect Keddie with Doyle by way of Indian valley, Greenville, Nevis, Big Meadows, Mountain Meadows, Susanville, and Honey Lake valley. Rights-of-way have already been secured and work will be commenced within a short time.——The Railroad Commission has granted permission to the San Jose Terminal Co. to issue bonds in the sum of $400,000, which sum is to be used for the construction of an electric railway between San Jose and Alviso and to establish their service between Alviso and San Francisco.——The Railway Commission has called upon all of the transportation companies for copies of their cur-

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rent working time-schedules as far as they affect improvements within the state of California.——The Southern Pacific Co. has completed all negotiations for the extensions of its transbay electric service from Alameda, Berkeley, and Richmond via Albany, as soon as permission has been received from the Railway Commission.——The Oakland, Antioch & Eastern railway has placed an order with the United States Steel Products Corporation for 10,000 tons of rail. Harrington & Waddell are the engineers who will be in charge of construction of the new bridge across Suisun bay at Chipps island. Contract has been let to the Standard American Dredging Co. for filling in the marsh lands along the right-of-way. Contract for constructing the under-crossing between the Southern Pacific tracks on the Contra Costa side of Suisun bay has been let to Palmer & McBride.

*Los Angeles.*—The Board of Public Works has ordered the city engineer, Homer Hamlin, to proceed with plans, specifications, and estimates for the construction of the municipal railway projected for San Pedro street. It is believed that the projected municipal railway will be built by the city and that the bid of the Pacific Electric Co. for the San Pedro street franchise will be ultimately rejected.——It has been stated that H. E. Huntington, of this city, will shortly become a director in the United Properties Co. and the other Smith-Tevis-Hanford interests of Oakland, to succeed R. G. Hanford, who is said to be about to sever his connection with this company.

*Martinez.*—It is stated that cars will be running between Oakland and Antioch over the line of the Oakland, Antioch & Eastern railway by May 1, 1913.

*Suisun.*—Grading is commencing on the right-of-way for the Oakland, Antioch & Eastern railway through the eastern part of Solano county.

*Stockton.*—The first trains to pass over the Tidewater & Southern railway left Stockton at 1 p.m. on October 5.

*Gerber (Tehama county).*—Southern Pacific Co. is spending an appropriation of $91,000 on the erection of a terminal, filling and grading, round-house, and other buildings.

*Visalia.*—It has been stated that the Southern Pacific Co.'s branch lines will be electrified at this point.

*Long Beach.*—The Pacific Electric is contemplating improvements that will cost approximately $170,000. Heavy rails will be substituted for the light rails now in use. Several miles of track will be reballasted.

## Irrigation and Water Supply

*San Francisco.*—Board of Supervisors has passed a resolution providing for the extension of the water delivery mains irrespective of the purchase of the Spring Valley Water Co. Announcement has been made of the sale of the Yolo Water & Power Co. to a syndicate of New York bankers for a sum which is stated to be $10,000,000. Roy M. Pike represents White & Co., the new purchasers, and has opened headquarters in San Francisco. Yolo Water & Power Co. was formerly controlled by Thomas Prather, and his associates, with offices in the Mechanics Institute building, San Francisco. Ultimately 200,000 acres of land in Yolo county will be placed under irrigation. It is proposed to build a dam and storage reservoir at Clear Lake.——The State Railway Commission is considering the application of the Sutter Butte Canal Co. for permission to issue $129,000 in 6% bonds. W. M. Sheldon is vice-president and H. T. Cory is chief engineer.

*Los Angeles.*—The Tejunga Water & Power Co. of this city, of which Thomas M. Dack is president, has applied to the State Railway Commission for permission to issue $300,000 of a projected bond issue of $1,000,000 to cover improvements. H. A. Hanson, general manager for the company, states that a dam is to be constructed with a storage capacity of 1500 miners' inches to provide a supply of water for the irrigation of 10,000 acres. A 6000-hp. hydro-electric power plant is to be constructed at Sunland and a conduit for water and power will be constructed. The City Council will make a rate of 2c. per miners' inch for the surplus aqueduct water when used for irrigation purposes. The voters will pass upon a proposal for the distribution of surplus aqueduct water through conduits built by the city to carry water for use on any part of approximately 250,000 acres. The plan will call for the expenditure of approximately $8,400,000 additional for the construction of the dis-

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tribution system; also for 25 miles of steel pipe for the Franklin canyon line, which will connect the end of the Owens river aqueduct with the city water mains. Bids for furnishing the steel and rivets for the Franklin canyon 6-ft. conduit to bring Owens river water to the city were as follows: Lacy Manufacturing Co., of Los Angeles, $575,673, under schedule 'B'; Riter-Conley Co., of Leetsdale, $276,000, under schedule 'A.' The first schedule calls for delivery of the fabricated work at the trench in the San Fernando and the second calls for a price at the point of manufacture. Freight added to the Leetsdale firm's bid may be about the same as the Lacy company. Other bidders were: Schedule 'A'—East Jersey Pipe Co., Paterson, New Jersey, $435,555, lock bar $423,675; Treadwell Construction Co., from $297,000 on 400 days delivery to $347,000 on 300 days delivery; Carl Porter Boiler Co., Wellsville, Ohio, $357,000; R. D. Wood & Co., Camden, New Jersey, $399,000. Schedule 'B'—Treadwell company, $650,000 (800 days delivery); James McNeil & Bro. Co., Pittsburg, $626,000; Carl Porter company, $630,000; Riter-Conley Co., $670,000. Contracts were let as follows: Lacy Manufacturing Co., of this city, $281,700, pipe to be delivered beside the ditch, and to the Riter-Conley Co., Pittsburg, $141,065 f.o.b. Pittsburg. A syndicate of Los Angeles men, including L. S. Adams, George C. Epstein, James E. Bastable, Frank Shaw, J. C. Adams, and Frank Lower, has purchased from the San Luis Rey Land Co. the Puama ranch in San Diego county, comprising approximately 20,000 acres, at a price of about $500,000. The new owners propose to develop water for irrigation and power purposes and will spend approximately $150,000, making improvements.——It has been announced by chief engineer, William Mulholland, that the Los Angeles aqueduct will be completed January 10, 1913. The aqueduct is 240 miles long and will have a capacity of 450 second feet, or enough to supply a city of approximately 4,000,000 persons.

*Pasadena.*—The city of Pasadena will apply to the Los Angeles Department of Public Service for 500 inches of water from the Owens river aqueduct. The city has paid $807,098.89 to the Pasadena Lake Vineyard Land & Water Co. and to the Pasadena Land & Water Co. for their properties in this city and in the nearby mountains for the purpose of owning a municipal water supply. It is expected that the North Pasadena Land & Water Co. will also be purchased for approximately $250,000.

*Riverside.*—Messrs. Burns and McDonnell, consulting engineers of Kansas City, Missouri, have made appraisal of the three operating water companies at Riverside, and at a meeting of the City Council the report and recommendations were unanimously adopted, and the mayor was directed to negotiate for the purchase by the city of the Riverside, Artesia, and Kyes plants. An amount in excess of a million dollars will be required, of which about $340,000 will be expended for necessary improvements and extensions.

*Colfax.*—The Pacific Gas & Electric Co. has commenced active work toward enlarging the irrigation ditch between Colfax and Clipper Gap to bring its capacity up to 150 cu. ft. per second.

*Alturas* (Modoc county).—Officers of the U. S. Forestry Service are surveying proposed reservoir sites at Rattlesnake near Alturas. One site has been selected that will provide 50,000 acre-feet of water and which could be developed at a cost of approximately $100,000.—The Crocker-Huffman Co. has let a contract to the Hanson Contracting Co. for the construction of a reservoir at Cloverswale, 15 miles west of Alturas.

*Richmond.*—Steps have been taken toward the formation of a county water system in Contra Costa county which will serve the towns of Martinez, Pittsburg, Bay Point, Rodeo, and Pinole and will involve the expenditure of approximately $2,500,000.

*Suisun.*—Town Trustees have passed resolutions calling for a special election to vote on a proposition to issue bonds for the purpose of providing funds for the construction of a two-mile pipe-line for a municipal water system.

*Vacaville.*—The Tulare Water Co. has offered to sell its water plant and distributing system to the city for a sum of $50,000. A report on the value of the Tulare company's property is being made.

*Klamath Falls, Oregon.*—Contract for the second unit of the Klamath Falls irrigation project was awarded to Mahoney Brothers, and active work was commenced on October 21.

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## Petroleum

*San Francisco.*—Standard Oil Co. is preparing to install a large number of small refineries at various points within the California oilfields. The first of these plants will be erected in the Kern river field on 40 acres of oil land recently purchased from the Peerless Oil Co. The Standard Oil Co. has announced that they will buy no more oil heavier than 18°B. Over fifty oil producers are affected by this ruling. A meeting has been held at Bakersfield by representatives of the companies affected who have taken preliminary steps toward the organization of a selling company in order to market their own product. A committee, consisting of Timothy Spellacy, G. A. Barlow, T. H. Miner, L. P. Guiberson, and H. H. Jastrow, has been appointed to perfect plans of organization and confer with the other large oil selling companies to see what arrangement can be made for the disposal of their output. Twenty-seven companies are represented in the new organization.——A proposal of the Kern Trading & Oil Co. to increase its capital stock from $1,000,000 to $10,000,000 has been ratified. Frank Neitzel, of the Union Iron Works, has returned from a trip through Europe and reports that the Diesel internal combustion engine is superseding all other types of prime mover for power generation.

*Los Angeles.*—R. E. Cahill, U. S. Commissioner of internal revenue has acquiesced in the proposed reduction of the new Federal corporation tax and will co-operate with the representatives of the oil companies looking toward a means of reducing their taxes.——Average price of oil shown by the monthly returns to the members of the Independent Producers Agency show 34c. per barrel for August, as compared with 33⅛c. per barrel in July.——The City Council has approved a project for the oil loading and unloading system of the General Pipe-Line Co. on the break-water at San Pedro harbor.

*Bakersfield.*—It is stated that the General Petroleum Co. will have completed its system from the Upper Midway field to San Pedro harbor on or before February 1, 1913. The distance traversed is 154 miles and it is considered that the time consumed establishes a new record for this class of work and that the constructing engineers have achieved a remarkable accomplishment in carrying this work through to a successful conclusion in such good time. Thirty thousand barrels is the daily capacity of the pipe-line. Twelve pumping stations are being installed.——The West Shore lease in the Kern River fields is erecting a plant for the manufacture of gasoline by the Stone process. The Monte Cristo lease is also erecting a similar plant; 14 gravity oil is used, from which 63 gravity gasoline is produced, the ratio of extraction being approximately 1 in 20.

*Brea.*—The Southern Counties Gas Co. is seeking to purchase the natural gas output of all companies in Brea canyon. The total output will amount to approximately 5,000,000 cu. ft. per day and it is proposed to pipe it to the town of Orange and adjoining territory.

SEPTEMBER PRODUCTION

| | Gross bbl. | Fuel. |
|---|---|---|
| Coalinga | 1,603,979 | 63,333 |
| Kern River | 1,039,864 | 175,000 |
| McKittrick | 550,061 | 28,217 |
| Maricopa | 555,859 | 45,826 |
| Midway | 2,262,255 | 72,507 |
| Lost Hills | 123,809 | 7,828 |
| Santa Maria | 446,712 | 9,290 |
| Olinda-Brea-Puente | 518,561 | 5,177 |
| Salt Lake | 224,552 | 2,641 |
| Whittier | 59,379 | 2,675 |
| Coyote-La Habra | 146,960 | 490 |
| Los Angeles City | 33,342 | 1,500 |
| Summerland | 4,950 | 600 |
| Newhall | 9,967 | 745 |
| Ventura County | 62,446 | 4,470 |
| Totals | 7,642,426 | 420,299 |

STOCKS

| | Field. | Pipe-line. | Total. |
|---|---|---|---|
| Coalinga | 351,972 | 2,809,295 | 3,161,267 |
| Kern | 393,681 | 29,203,884 | 29,597,565 |
| McKittrick | 173,750 | 672,414 | 846,164 |
| Maricopa | 398,822 | 268,300 | 667,122 |
| Midway | 507,190 | 1,578,692 | 2,085,882 |
| Lost Hills | 29,000 | 57,339 | 86,339 |
| Santa Maria | 312,545 | 343,149 | 655,694 |
| Fullerton | 39,129 | 56,730 | 95,859 |
| Salt Lake | 146,284 | 48,614 | 194,898 |
| Whittier | 31,101 | ..... | 31,101 |
| Coyote | 33,436 | ..... | 33,436 |
| Los Angeles | 15,000 | 276,181 | 291,181 |
| Newhall | 4,289 | ..... | 4,289 |
| Ventura | 17,991 | 20,724 | 38,715 |
| Miscellaneous | ..... | 8,884,660 | 8,884,660 |
| Totals | 2,454,190 | 44,219,982 | 46,674,172 |

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DIVIDENDS FOR SEPTEMBER

| | | |
|---|---|---|
| Amalgamated | $1.00 | $50,000.00 |
| American Petroleum pfd. | 0.005 | 8,755.50 |
| do common | 0.001-3 | 39,607.00 |
| Caribou | 0.001-3 | 8,070.30 |
| Central | 0.0075 | 7,500.00 |
| Claremont | 0.01 | 5,000.00 |
| Columbia | 0.01 | 9,992.26 |
| Del Rey | .. | 3,000.00 |
| Euclid | .. | 1,750.00 |
| Home | 0.01 | 5,000.00 |
| Midway Premier | 0.01 | 5,000.00 |
| Monte Cristo | 0.025 | 12,500.00 |
| Mount Diablo | 0.015 | 7,500.00 |
| New Pennsylvania | 0.005 | 5,000.00 |
| Pacific Crude | 0.10 | 60,000.00 |
| Paraffine | 0.01 | 3,000.00 |
| Record | 0.01 | 5,000.00 |
| Rice Ranch | 0.015 | 4,500.00 |
| S. F. & McKittrick | 0.01 | 5,000.00 |
| Sauer Dough | 0.0075 | 2,992.50 |
| Section Twenty-five | 0.50 | 20,000.00 |
| State Consolidated | 0.01 | 5,000.00 |
| Traders | 0.006 | 9,000.00 |
| Union Oil | 0.006 | 184,743.60 |
| Union Provident | 0.006 | 91,402.02 |
| United Petroleum | 0.006 | 48,450.60 |
| W. K. | 0.02 | 10,000.00 |
| Western Union | 0.005 | 5,000.00 |
| Total California companies | | $602,763.78 |

## Panama-Pacific Exposition

Rodney S. Durkee, controller of the Panama-Pacific International Exposition has filed his report with Charles C. Moore, the president, giving a statement of the income, expenditures, and subscription accounts for the entire period from the commencement of business in December 1909 to September 30, 1912, as follows:

INCOME

| | |
|---|---|
| Payment on subscriptions | $2,325,801.29 |
| Other sources | 33,444.66 |
| Total receipts to date | $2,359,245.95 |

EXPENDITURES

| | |
|---|---|
| Prelim. period ended Sept. 30, '11 | $377,515.01 |
| Real estate purchased | 305,166.62 |
| Impvts. pur., leases, site rentals | 463,439.65 |
| Buildings and grounds | 340,342.23 |
| Administration | 59,942.13 |
| Exploitation | 74,382.71 |
| Exhibits | 33,373.49 |
| Concessions and admissions | 4,519.61 |
| Reception | 6,303.12 |
| European Commission | 37,866.74 |
| Legal Department | 5,144.42 |
| Protection | 369.30 |
| Conventions and societies | 1,328.71 |
| Furniture and equipment | 17,294.49 |
| Unclassified and unassigned | 2,213.29 |
| Total expenditures to date | $1,729,201.52 |
| Unexpended balance | $630,044.43 |

Unexpended balance represented by:

| | |
|---|---|
| Cash | $506,470.94 |
| Deposit as security on leases | 133,000.00 |
| Accountable advances | 3,568.73 |
| Items in suspense | 1,794.68 |
| Store supplies and postage | 1,142.03 |
| Accounts receivable | 126.90 |
| Total | $646,103.28 |
| Less accounts payable | 16,058.85 |
| | $630,044.43 |

SUBSCRIPTION ACCOUNT

| | |
|---|---|
| Total signed subscriptions to date (14,335) | $6,095,350.00 |
| Paym'ts on subscriptions, 38.16% | 2,325,801.29 |
| Overdue subscriptions, 1.84% | 112,338.71 |
| Installments not yet due, 60% | 3,657,210.00 |

VARIOUS AMOUNTS PLEDGED

| | |
|---|---|
| Knights of the Royal Arch | $250,000 |
| Hotel Men's Association | 250,000 |
| Chinese merchants, San Francisco | 50,000 |
| Japanese merchants, San Francisco | 50,000 |
| Retail Cigar Dealers of S. F. | 25,000 |
| Miscellaneous | 54,580 |
| City of Oakland | 1,000,000 |
| Total | $1,679,580 |

The accounts of the company have been fully audited by public accountants for entire period to September 30, 1912.

R. S. DURKEE, Controller.

Approved: Leon Sloss, M. J. Brandenstein, John A. Britton, auditing committee.

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# Hints on Practice

RED LEAD CEMENT for face joints can be made of 1 part of white lead, 1 of red lead, mixed with linseed oil to the proper consistence.

A VARNISH suitable for covering tracings may be prepared from equal amounts of Canada balsam and oil of turpentine, by dissolving the balsam in the latter.

AN EMULSION of equal parts of rum and olive oil can be used for cleaning aluminum. Potash lye not too strong is also effective in brightening aluminum; benzol is also used.

A CEMENTING MIXTURE for leather is made by melting 1 part of shellac, 2 parts of pitch, 4 parts of india-rubber, and 16 parts of gutta-percha, in 2 parts by weight of linseed oil, and mixing them well. The smaller the solid ingredients are cut before being put into the pot, the easier and more efficient will be the mixing.

WHEN tempering springs allow the oil to burn about six minutes before quenching. As the oil can be heated to only a certain temperature, the articles receive a perfectly even heat. If the oil is burned off from the article while it is only smeared with oil, some parts will be heated more than others. If a spring is made of piano wire, it will be greatly stiffened and improved by heating it to an even blue after it is formed. The reason for this is that when the wire is coiled the metal is full of strains, which the heat removes.—*Mechanical World.*

A RUST-JOINT CEMENT is prepared from 1 part of powdered sal-ammoniac, 2 parts of flowers of sulphur, and 100 parts of iron borings. These are mixed into a paste with water and applied for jobs which are wanted in a hurry, as this is a fairly quick setting mixture. If there is no particular hurry for the job, a slower setting mixture can be made by doubling the sal-ammoniac and iron borings, while halving the flowers of sulphur, so that the mixture is proportioned 2 parts of sal-ammoniac, 1 part of flowers of sulphur, and 200 parts of iron borings.

IT IS SAID that cast iron can readily be soldered if the following instructions are followed: Make an amalgam of tin filings and mercury. What is not used at once can be kept in a wide-mouthed glass bottle for future jobs. The joint is first cleaned thoroughly, then a clean rag is dampened with commercial muriatic acid, and some of the tin-mercury amalgam is rubbed well into the cleaned joint. Soldering is then proceeded with in the usual way, using soldering salts as a flux.

IT is only within the last few years that the exhaust-steam turbine has been utilized in improving the steam consumption of power plants. The installations to which publicity has been given have been of large units, and engineers of small power plants may have gained the impression that the adoption of small exhaust-steam turbines is not practicable. When the load on a small power plant increases beyond the capacity of the engine, there are several ways of securing more power. One is to install a larger or additional engine, which would demand additional boiler capacity, and in instances an enlarged boiler-house. Another is to install a condenser, if the engine has been operating non-condensing, and obtain an additional output of between 20 and 25%. Installing a low-pressure turbine between the engine and the condenser is the latest way. Small turbines can be operated with a jet condenser, maintaining a vacuum of from 24 to 26 in., or a surface condenser can be used for higher vacuum. Much of the energy remaining in the steam after passing through the cylinder of a reciprocating engine with its limited range of expansion can be recovered in an exhaust-steam turbine, because the latter greatly extends the range of expansion. Often the turbine gets as much out of the steam as does the engine through which the steam first passes. Engineers whose plants are being forced should look well into the merits of the exhaust-steam turbine from the standpoints of economy, small space occupied, and low initial cost.—*Power.*

METHOD of making brass is as follows:

1. Melt the copper with gates or scrap.
2. Add the spelter when these have melted.
3. Then add the tin.
4. And finally the lead.

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# Engineers' Note Book

According to Church's *Hydraulics*, a general equation for friction is

$$P = \frac{f\,s\,y\,v}{A\,2\,g}$$

for any pipe, and

$$P = \frac{4\,f\,y\,L\,v}{2\,g\,D}$$

for round pipe.

$y$ = weight of 1 cu. ft. of air
$P$ = pressure in lb. per sq. ft.
$L$ = length of pipe in feet
$D$ = diameter of pipe in feet
$f$ = coefficient of friction
$v$ = velocity in feet per second
$s$ = perimeter of section of pipe

The coefficient of friction ordinarily employed for standard piping is 0.0067.

---

In calculating sizes of chimneys where oil is used as fuel for the generation of steam, W. F. Durand says

$$(A - a)\sqrt{h} = \frac{B\,y}{Q\,e}$$

where

$A$ = area of chimney in sq. ft.
$a$ = small constant
$h$ = height in feet
$B$ = boiler hp. actually developed which equals number of pounds of total evaporation per hour reduced to conditions from and at 212°F. divided by 34.5.
$e$ = boiler efficiency
$y$ = temperature factor from table
$Q$ = coefficient

Values of $a$ and $Q$ are as follows:

For large chimneys or from 300 boiler hp. up

$a = 2.5$
$Q = 54$

For small chimneys or from 500 hp. down

$a = 0.6$
$Q = 40$

The values given for $Q$ are based on

Heat value for oil fuel, about 18,500 b.t.u.
Temperature of external air, 80°F.
Excess of air in furnace, about 100%.
Boilers working at rate of output not greatly exceeding rated load.

VALUE OF TEMPERATURE FUNCTIONS

| Temp. | $y$ | Temp. | $y$ |
|---|---|---|---|
| 400 | 4.19 | 560 | 4.02 |
| 420 | 4.16 | 580 | 4.01 |
| 440 | 4.12 | 600 | 4.00 |
| 460 | 4.10 | 620 | 4.00 |
| 480 | 4.07 | 640 | 4.00 |
| 500 | 4.05 | 660 | 4.00 |
| 520 | 4.04 | 680 | 4.00 |
| 540 | 4.03 | 700 | 4.00 |

---

In discussing the relation between specific gravity and the Baumé scale as applied to California fuel oils, J. N. Le Conte gives the following formulæ:

$$\text{Specific gravity} = \frac{140}{130 - B}$$

$$B = \frac{140}{\text{specific gravity}} - 130$$

---

According to E. C. Jones, a typical analysis of producer gas made from California crude oil is as follows:

| | Per cent. |
|---|---|
| Carbon dioxide | 4 |
| Heavy hydrocarbon | 2 or less |
| Oxygen | 1 |
| Carbonic oxide | 10 |
| Hydrogen | 5 |
| Marsh gas | 8 |
| Nitrogen | 70 |
| | 100 |

---

A formula for solid roller bearings is as follows: Where

$P$ = load on bearings in pounds
$i$ = number of rollers
$d$ = diameter of rollers in inches
mean diameter of cones
$l$ = working length in inches
$P = c\,i\,l\,d$

Rollers must be designed so that the load $P$ will be properly distributed over the length of $l$ and the number $i$ of the roller. $c$ has the following values:

Rollers and tracks hard cast iron... $c = 350$
Rollers and tracks hard steel..... $c = 850$

Should $l$ be less than 5 $d$, $c$ should be taken correspondingly smaller. With hardened steel rollers and bushings, $c$ may reach 2100.

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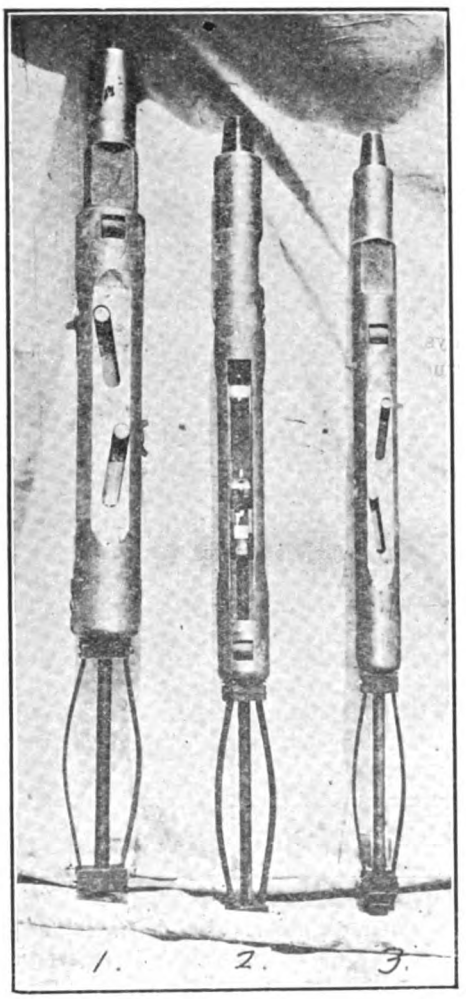
# Industrial Progress

## Improved Oil-Well Casing Perforator

**By F. M. MACK***

One of the latest oil tools that has been put in operation, and one that is proving to be successful, is an improved double casing perforator designed by me, and on which



MACK CASING PERFORATOR.

I have applied for letters patent. This tool, instead of being run on a string of tubing as has been the custom heretofore, is run on an ordinary string of 'fishing' tools, being let out by the temper-screw the same as in drilling. This, in itself, is a great time and labor saver, and does away with the great strain on the casing incident to running the perforators on the tubing in the old way. The perforator is equipped with two wheels into which the teeth or punches are inserted, and perforates two rows of holes at one time. It is also provided with rollers which take the thrust of the wheels, thus doing away with all friction on the casing. In addition, it is fitted with other rollers which overcome any possibility of flattening the casing while operating the tool.

One of the great troubles with tools of this kind has been the damage done to the casing, due principally to the weight of the stems, tubing filled with water, and the method used in running the tool which causes a tremendous pressure to be exerted against the casing, and at the same time causing the wheels to tear the casing after perforating the holes. All of this has been entirely overcome by this tool, as there is absolutely no friction whatever.

No bridging of the hole is required when this tool is used, the tripping mechanism being the same as on the ordinary casing splitters. In operating the tool, it is attached to an ordinary string of 'fishing' tools and lowered to the lowest joint of casing that is to be perforated. By raising the tool a few inches, the perforator is tripped and ready for work. The cable is then connected to the temper-screw and the method followed from this point is the same as drilling, except that the screw is let out much faster. After perforating the lower joint to the collar, which can easily be felt as soon as it is reached, the tools are raised to the next joint above, and so on until the required number of joints have been perforated. This tool is past the experimental stage, having been almost universally adopted in the Coalinga field, where it is being handled by the California Oilfields, Ltd., and a number have recently been placed in Taft, California, by the Midway Fishing Tool Co., who handle their distribution in this territory.

*Oilfields, California.

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On her second trip the new Diesel motorship *Eavesstone* has arrived at the port of Gefle, Sweden, after a successful non-stop voyage from the North of England.

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## Personal

BION J. ARNOLD and J. R. BIBBINS are in San Francisco.

H. FOSTER BAIN will return to San Francisco November 5.

J. W. WHITE will engage in consulting practice, with offices in the Mills building, San Francisco.

JULIUS KRUTTSCHNITT has been inspecting the Southern Pacific electric suburban service in Alameda county.

H. L. QUIGLEY has gone to Seattle and will visit Portland, Tacoma, and Spokane before returning to San Francisco.

E. H. BENJAMIN has gone to Cleveland, Ohio, to attend the meeting of the American Institute of Mining Engineers.

C. E. GRUNSKY has been retained by the city of Sacramento to represent the city in its petition for the formation of a reclamation district across the American river.

## Obituary

JAMES O'BRIEN GUNN died from an attack of paralysis at San Francisco on Monday, October 21, at the age of 69 years. Mr. Gunn was a native of Canada who came to California in early days and became associated with Messrs. Crocker, Stanford, Huntington, and Hopkins, and took a prominent part in the organization of the Central Pacific railroad, afterward becoming secretary of the California Pacific Co., one of the Central Pacific subsidiaries. In 1883 Mr. Gunn joined with Henry T. Scott and the late Irving M. Scott in the formation of the Union Iron Works, and was a potent factor in the creation of the shipbuilding industry on the Pacific Coast. Mr. Gunn was noted for his kindly feeling toward younger men trying to make their way, and his ready sympathy and unostentatious generosity endeared him to all whose privilege it was to know him.

## Society Meetings

THE Engineers' Club of San Francisco, at a meeting held on Tuesday, October 22, passed a resolution authorizing the council to incorporate and take such steps as were necessary to provide the Club with permanent headquarters. A committee on membership was appointed by A. H. Babcock, vice-president, consisting of S. K. Colby, W. W. Briggs, M. H. Peck, T. T. Read, Thomas Morrin, and R. A. Gould.

AT a meeting of the directors of the Independent Oil Producers' Agency at Bakersfield on October 29, resolutions were reaffirmed against receiving from the individual members more oil each month than required to meet the current sales. L. P. St. Clair was authorized to prorate deliveries from the companies interested. The Union Development Co., the Oil Exploration Co., and the Miocene Oil Co. were admitted to membership.

## Commercial Paragraphs

The ORENSTEIN, ARTHUR KOPPEL CO. announces that the increase in demand for Koppel equipment during the past three years has been so great that it is necessary for A. A. Prausnitz, associate Pacific Coast manager, to proceed to the main offices of the corporation at Berlin in order to discuss ways and means for providing for the increased trade.

SMITH, EMERY & CO., industrial engineers of San Francisco, have been retained by the Old Mission Portland Cement Co. to design and erect a complete cement plant, which will include additions to the works formerly known as the San Juan Portland Cement Co. It is expected that the mill will be completed and ready for operation in time to compete for a share of spring business.

## Catalogues Received

The HINMAN HYDRAULIC MFG. CO., of Denver, Colorado, has issued an exceptionally attractive catalogue, No. 12-A, covering head gates, gate lifts, and their special type of metal flume known to the trade as 'Hydroduct.' This catalogue is of the loose-leaf order, is exceptionally complete, and contains, in addition to descriptive matter, illustrations, schedule of prices, and a complete set of velocity and discharge tables for 'Hydroduct' in all sizes up to 13.69 in. diameter.

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